

The University of Chicago

THE PHYSICAL GROWTH OF MENTALLY DEFICIENT BOYS

A DISSERTATION SUBMITTED TO THE
FACULTY OF THE DIVISION OF THE
SOCIAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATION

1933

By
CHARLES D. FLORY

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C. D. F.

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CHAPTER I

THE PROBLEM AND TECHNIQUES

The discovery of the Wild Boy of Aveyron in 1797 marks the awakening of the interest of educators in mentally deficient children. A group of French scientists, led by Itard and Seguin, worked arduously in an attempt to educate this mentally deficient boy. The failure to civilize the "Wild Boy" caused Itard to give up the undertaking in despair, while Seguin continued his interest in backward and mentally deficient children. It was the influence of Seguin which led to the establishment of special institutions for mental defectives just prior to 1850 both in Europe and in America. The first state institution in the United States for feeble-minded children was established in Massachusetts in 1849. State responsibility for mental defectives has continued to increase. Forty-four states have provided public institutions for mentally deficient persons. Public school systems, particularly in the larger cities, have organized special classes for dull and retarded pupils. Psychological tests have made it possible to determine whether a given individual needs remedial instruction, institutional protection and training, or merely custodial care. The states have seen fit to provide training for a large portion of the youth who are committed to public institutions for mental defectives. Attempts are being made to develop suitable curricula and to find educational activities for children who can not be trained in the regular public school system.

State institutions for mental defectives became a part of the educational system when mere custodial care was supplemented by training. The management of the educational program in such institutions raises certain fundamental problems in connection with the development of subnormal children. If the period of growth is rapid but short, the educational effort should be intensive in character. An extended period of immaturity may best be served by increasing the training period to harmonize with the rate of development. Tasks must be provided and standards established which will produce maximum development in the growing child. The efficient training of subnormal pupils is dependent upon an adequate understanding of the physical growth and development of mentally deficient children.

Statement of the Problem

It is the purpose of this investigation to study the physical growth of institutionalized mentally deficient boys. The statements of most authorities are in agreement that mental defectives are below average in height and weight. How much do they differ in these respects? Is the difference constant from age to age or do individuals of different levels of mental ability grow at different rates? Do mentally deficient children grow faster than, at the same rate, or slower than normal and superior children? Is mature ossification the same for all persons without regard to their mental level or is there a difference in the quality of skeletal development which is associated with the degree of brightness? Is there a relationship between pubescence and mental ability, when secondary sex characteristics are used as a criterion of puberty? If mentally deficient youth are more heterogeneous, as is commonly believed, what does the greater variability indicate with respect to growth? Can environmental and hereditary factors be discovered which have an influence upon the growth of mental defectives? If aments are found to be inferior in physical growth, is the deviation related to the degree of mental defect? These major issues will be raised and answered in so far as the available data will permit.

Related Studies

General books.—The literature dealing with the physical growth of mentally deficient children is very meager. There are certain general treat-

tises which discuss causes, consequences, incidence, classification, diagnosis, treatment, training, and distinctive characteristics of mental defectives. The opinion of students of mental deficiency has been influenced very greatly by these general works.¹

Physique and mental abilities.— Studies which attempt to determine the general relationship between physique and mental abilities have some bearing upon the present problem. The literature which treats this aspect of the problem has been so adequately reviewed in two recent works² that it would be sheer repetition to attempt another summary. Small consistent relationships have been found between mental development and physical growth. The writer feels that attempts to compare groups have been complicated by the types of samples which have been employed. If the groups are too small the differences may be obscured by irregularities in the growth curves. A comparison of two groups which are relatively equal in mental ability is not likely to reveal wide differences in physical development. If differences exist, a comparison of two groups vastly different in intellectual ability should yield the most positive results.

Studies of carpal development.— There have been a number of studies of the carpal ossification of normal children. Very few attempts have been made to apply the techniques to a study of mentally deficient subjects. The best list of references on ossification in normal persons has been published by the University of Iowa.³ The technique reported by Freeman and Carter is important in this connection because the writer has employed the same method for a portion of his analysis.⁴ Prescott has reported a few case studies of carpal development in mental defectives.⁵ His data are too meager to justify any conclusions with reference to the physical growth of mentally deficient subjects. Long and Caldwell's study⁶ of idiots and normal children used approximately 200 subjects ranging in age from infancy to maturity. They concluded that there is no relation between the degree of ossification and the quality of mind. Englebach and McMahon have shown⁷

¹ Martin W. Barr, Mental Defectives: Their History, Treatment, and Training. Philadelphia: P. Blakiston's Son and Co., 1904. Pp. x + 368.

Henry Herbert Goddard, Feeble-mindedness: Its Causes and Consequences. New York: Macmillan Co., 1914. Pp. xii + 599.

Abraham Myerson, The Inheritance of Mental Disease. Baltimore: William and Wilkins Co., 1925. Pp. 336.

Leta S. Hollingworth, Psychology of Subnormal Children. New York: Macmillan Co., 1920. Pp. xix + 288.

A. F. Tredgold, Mental Deficiency. New York: William Wood and Co., 1929. Pp. xvi + 535.

² Donald G. Paterson, Physique and Intellect. New York: The Century Co., 1930. Pp. xxvii + 304.

Ethel Mae Abernethy, Relationships between Mental and Physical Growth, Chapter II. Unpublished Doctor's Thesis, Department of Education, The University of Chicago, 1933.

³ Bird T. Baldwin, Laura M. Busby, and Helen V. Carside, Anatomic Growth of Children. University of Iowa Studies, Series No. 164, Vol. IV, No. 1, October 1, 1928. Pp. 88.

⁴ Thomas M. Carter, "Technique and Devices Used in Radiographic Study of the Wrist Bones of Children," Journal of Educational Psychology, XVII (April, 1926), 237-47.

Frank N. Freeman and Thomas M. Carter, "A New Measure of the Development of the Carpal Bones and Its Relationship to Physique and Mental Development," Journal of Educational Psychology, XV (May, 1924), 257-70.

⁵ Daniel Alfred Prescott, The Determination of Anatomical Age in School Children and Its Relation to Mental Development. Harvard Monographs in Education, Series No. 5. Cambridge, Mass.: Harvard University, 1923. Pp. iii + 59.

⁶ Eli Long, and E. W. Caldwell, "Some Investigations Concerning the Relation between Carpal Ossification and Physical and Mental Development," American Journal of Diseases of Children, I (February, 1911), 113-38.

⁷ William Englebach and Alphonse McMahon, "Osseous Development in Endocrine Disorders," Endocrinology, VIII (January, 1924), 1-53.

that disorders of the glandular system produce serious disturbances in the process of ossification. The incidence of glandular malfunctioning has not been determined for the mentally deficient class but it is the general opinion that aments are more likely to suffer from glandular disorders than are normal persons. A portion of the disorders observed may certainly be traceable to glandular malfunctioning. Cretinism is known to produce delayed ossification, while pubertas praecox is accompanied by accelerated bony growth. Clift made a definite study of mentally deficient individuals who were suffering from endocrine disturbances.¹ He found both retardation and acceleration among the defectives, depending upon the type of glandular disorder which was present. He concludes,

... we would state that the roentgen examination of the feeble-minded shows a very high percentage of malformations and developmental defects of the skull, that in those cases associated with endocrine disturbances there are as well marked changes in the process of bone development.

Anthropometric studies.— Paterson² has summarized very completely the literature dealing with anthropometric analyses of growth. Early anthropometric studies were confined in the main to height and weight. The conclusion has been reached that mentally deficient persons are below normal in stature and weight. Norsworthy,³ contrary to other investigators, reported that mentally deficient children are not distinguishable from the normal in height and weight. Doll attempted to devise an anthropometric aid for diagnosing mental deficiency.⁴ He studied sitting height, grip, and vital capacity in addition to height and weight. Doll concluded that mentally deficient persons are below normal in all of these physical traits. Aments are more heterogeneous than normal individuals according to the findings reported by Doll. The deviations were not closely enough associated with mental defectiveness so that a diagnosis could be made of individual cases from anthropometric records.

Several recent studies are in agreement with the earlier work. Rosenbluth found that,⁵ (1) the majority of mentally deficient individuals are retarded in height and the minority attain normal stature; (2) institutionalized mentally deficient children are strikingly heterogeneous in development; (3) the retardation is related to the severity of the malady. Strauss made a study of 100 aments, who in general appearance were developed normally. He found⁶ that no definite body types could be identified among the defective group. There was, however, a slightly greater incidence of femininity among mental defectives than among the normal population. Dayton has reported two studies⁷ which show that mentally deficient indi-

¹ M. William Clift, "Roentgen-Ray Studies of the Feeble-minded," American Journal of Roentgenology and Radium Therapy, XII (July, 1924), 23-27.

² Paterson, op. cit.

³ Naomi Norsworthy, "The Psychology of Mentally Deficient Children," Archives of Psychology, I (1906), 1-111.

⁴ Edgar A. Doll, Anthropometry as an Aid to Mental Diagnosis. Publication of the Training School at Vineland, New Jersey, No. 8, February, 1916. Pp. 91.

⁵ Alexander Rosenbluth, "Langen-und Massen wachstum Schwachsinniger Kinder," Zeitschrift für Kinderheilkunde, XLVI (1928), 548.

⁶ E. B. Strauss, "The Relation Between Feeble-mindedness and Physique," Zeitschrift für die gesamte Neurologie und Psychiatrie, CXXVII (1930), 225-39.

⁷ Neil A. Dayton, "Height, Weight, and Intelligence Relationships in 3,553 Retarded School Children," New England Journal of Medicine, CXCIX (1928), 934-38.
Neil A. Dayton, "The Relationship Between Physical Defects and Intelligence," Proceedings of the American Association for the Study of Feeble-minded, XXIV (May, 1929), 112-39.

viduals are below normal in height and weight. Smith found¹ from repeated measurements that the feeble-minded are a little less than one year behind the normal at age seven, but are three years below the norm at age seventeen. He reported that feeble-minded males complete their growth in height at seventeen or eighteen. He says,

The differences between the growth of normal and feeble-minded boys indicate that the feeble-minded not only grow more slowly but attain their growth sooner than the normal children.

Studies of other forms of development among mentally deficient individuals.- Mead has shown that mentally deficient children are very much retarded in learning to walk and talk.² Cattell failed to find, in her study of dentition,³ a clear cut difference between feeble-minded, dull, bright, and unselected individuals. She did suggest that dentition was related to other measures of maturity. Her study includes a review of the literature on dentition.

Green⁴ and Dayton⁵ show that mental defectives come from large families. Green reported that the death rate among mentally deficient persons is no higher than for the general population. Dayton, on the contrary, shows that the death rate is excessively high and is related to the degree of mental defect. Dayton based his conclusion on the records for 6,976 cases. The U. S. Public Health Reports⁶ confirm the contention of Dayton.

The incidence of stigmata among aments has been a relatively frequent topic of discussion but a rather infrequent subject for investigation. The two extremes in point of view are presented by Barr⁷ and Case.⁸ Barr contends that stigmata occur so frequently and in such severity that they serve as an aid in the diagnosis of amentia. Case reported that there is no greater incidence of anomalies in the hard palate of mental defectives than among so-called normal subjects. Myerson⁹ recorded the number of anomalies in 535 mental defectives. He concluded, "It may be stated that as a general proposition the institutional feeble-minded are feeble-bodied as well." Burke found a greater incidence of anomalies among mental defectives than among normal individuals. He contended, however, that the difference between normal and mentally deficient individuals is not as great as is generally supposed.¹⁰ Englebach and McMahon reported many

¹ C. Wilson Smith, "Growth in Height of Feeble-minded Children," Journal of Genetic Psychology, XXXVI (June, 1929), 330-41.

² Cyrus D. Mead, "The Age of Walking and Talking in Relation to General Intelligence," Pedagogical Seminary, XX (September, 1913), 460-84.

³ Psyche Cattell, Dentition as a Measure of Maturity, Harvard Monographs in Education, No. 9. Cambridge, Mass.: Harvard University Press, 1928. Pp. viii + 91.

⁴ Charles V. Green, "Birth and Death Rates of Feeble-minded," The Journal of Juvenile Research, XII (September-December, 1928), 244-48.

⁵ Neil A. Dayton, "Order of Birth and Size of Family," American Journal of Psychiatry, VIII (May, 1929), 981-1006.

Neil A. Dayton and Others, "Mortality and Expectation of Life in Mental Defectives in Massachusetts," New England Journal of Medicine, CCVI (March, 1932), 555-70 and 616-31.

⁶ U. S. Public Health Reports, United States Public Health Service, U. S. Treasury Department, Vol. 47, No. 27, July 1, 1932. Pp. 1440-41.

⁷ Martin W. Barr, "Observations on the Stigmata of Degeneration as Found in Feeble-minded," New York Medical Journal, CXII (July 17, 1920), 80-83.

⁸ Irene Case, "The Correlation between Mental Defect and Anomalies of the Hard Palate," American Journal of Insanity, LXXV (April, 1919), 501-20.

⁹ Abraham Myerson, "The Pathological and Biological Basis of Mental Deficiency," Proceedings of the American Association for the Study of Feeble-minded, XXV (May, 1930), 203-26.

¹⁰ Noel H. M. Burke, "Stigmata of Degeneration in Relation to Mental Deficiency," Proceedings of the Royal Society of Medicine, XXIV (February, 1931), 11-26 or 413-28.

cases of osseous anomalies¹ in persons who were suffering from some endocrine disorder. Jatho and Lundlun² and Stevenson³ called attention to the fact that there are internal stigmata among mental defectives. Internal anomalies have as yet received very little attention.

The evidence from the literature is somewhat conflicting. The trend of the evidence seems to indicate that mental defectives are shorter, lighter, die earlier, and exhibit more anomalies of development than normal and superior individuals.

Obtaining the Data

A growth study is dependent upon actual measurements of a large number of individuals. The data may be compiled either by repeated measurements of the same subjects over a period of years or by measuring different children at each age level. The latter method had to be employed in this study in order to keep within a reasonable time limit.

The subjects used.- The co-operation of the officials of the state institutions at Ft. Wayne, Indiana, and Lincoln, Illinois, has made the study possible. Arrangements for obtaining the subjects were completed in the autumn of 1931. It was decided that the subjects should be within the age range of five to twenty-five years. The lower limit was placed at five because few children reach the state institutions before the school age. The upper limit was placed at twenty-five in order to cover the period of growth.

The original plan was to select a minimum of fifty subjects at each age level with an approximately equal distribution in the three mentally deficient classes, namely, idiot, imbecile, and moron. It was soon discovered that the number of subjects available did not make possible as uniform a sampling as was desired. Idiots are not committed to institutional care in the earlier years in sufficient numbers to fill their age groups. Morons tend to leave the state institutions in the late teens either by parole or escape. All white boys between five and twenty-five years of age were measured and x-rayed, if they had no contagious disease and were physically able to stand the examination. Severe cripples, tubercular cases, and others who were suffering from some confining illness were omitted from the sample. The sampling contains, then, subjects who are the least abnormal in physique and the freest from physical disease.

The three classes have been designated as follows: Class A, idiots within the IQ range of 0 to 24; Class B, imbeciles with IQ's from 25 to 49; and Class C, morons with IQ's from 50 to 70, inclusive. The distribution of the subjects used in the study is given in Table I. A total of 874 individuals were measured and x-rayed, but 58 subjects were above 70 IQ, 13 were too old, two were below the age limit, and one pubertas praecox case will be treated separately. The sample used consisted of 800 subjects; 195 idiots, 289 imbeciles, and 316 morons.

The results obtained can be considered as typical of only a part of the mentally deficient population. The fact that the subjects were in state institutions means that they do not represent aments who are not institutionalized. There are reasons to believe that two types of deficient individuals remain in their homes; those who are helpless and infantile and

¹ Englebach and McMahon, *op. cit.*

² Edna R. Jatho and Seymour Dewitt Lundlun, "A Study of Internal Stigma of Degeneration in Relation to Metabolism and Disturbance of the Cerebral Cortex in Children," *Archives of Neurology and Psychiatry*, VII (February, 1922), 167.

³ George S. Stevenson, "The Physiology of the Feeble-minded," *Archives of Neurology and Psychiatry*, XVIII (April, 1925), 497-503.

TABLE I

AGE AND CLASS DISTRIBUTION OF THE SUBJECTS USED IN THE STUDY

Age	Class A (Idiot)	Class B (Imbecile)	Class C (Moron)	All Classes
5	1	2	4	7
6	1	2	11	14
7	5	10	8	23
8	5	12	13	30
9	6	9	21	36
10	9	20	21	50
11	6	15	25	46
12	9	23	28	60
13	11	23	21	55
14	13	20	29	62
15	18	18	20	56
16	13	20	21	54
17	18	22	17	57
18	14	18	15	47
19	9	17	17	43
20	20	15	12	47
21	13	12	15	40
22	8	9	5	22
23	7	11	7	25
24	8	8	4	20
25	1	3	2	6
Total	195	289	316	800

those who are economically productive. The proportion of all mentally deficient persons which is under state supervision can be determined if the incidence of amentia and the population of the institutions are known. The U. S. Public Health Reports reveal that state institutions have an enrolment¹ of mental defectives which exceeds 42,000. First admissions in the last quarter of 1930 totaled 673 males and 455 females. During the same period 302 males and 221 females were discharged. Approximately 13 per cent of the inmates are on temporary leave during any given month. These figures show an increasing institutional population, but also a large turnover in the enrolment.

The incidence of mental deficiency in the general population has been estimated by various writers to be from 1 to 5 per cent. Popenoe's survey of 219 elementary schools which enrolled 80,988 children revealed that 4.35 per cent of the pupils fell below an IQ of 70. He concluded² that one would be justified in saying that 4 per cent of the general population would be diagnosed as mentally deficient by the present tests. Kuhlmann³ found from a survey of the State of Minnesota that more than 4 per cent of the population were so low in mental ability that they would be considered mental defectives. The incidence of mental deficiency in the general population is determined by the standards used in making the diagnosis. Since the distribution of intelligence is continuous, one of the most satisfactory definitions of mental deficiency is that percentage of the population which falls below a given point on the scale. The high death rate among

¹ U. S. Public Health Reports, *op. cit.*

² P. Popenoe, "The Extent of Mental Disease and Defect in the American Population," *Journal of Juvenile Research*, XIII (April, 1929), 97-103.

³ F. A. Kuhlmann, "State Census of Mental Defectives," *Journal of Delinquency*, VIII (September-November, 1923), 247-62.

low grade individuals indicates that the percentage decreases with an increase in chronological age.

If only 1 per cent of the population suffer from amentia, then 3.5 per cent of the feeble-minded are in state institutions. On the other hand, if 4 per cent is a more accurate estimate, then less than 1 per cent of the aments are charges of the states. In either case, the findings of the present study pertain to a relatively small proportion of the mentally deficient group.

The study has been confined to whites in order to reduce the race factor. The distribution of the nationality of the subjects studied is given in Table II. The percentages were calculated for the entire group and for the portion of each group for which the nationality was known, since data were not obtainable for each subject. More than 75 per cent of the subjects whose nationality was given were classified as Americans. The Poles were the only other group which accounted for as much as 5 per cent of the sample. The distribution indicates that the nationality of the subjects need not be considered an important factor in the interpretation of the results.

The information collected.— Each subject was given a number, as his measurements were begun, which served to identify his roentgenogram, his history, and his measurement record. Five types of data were collected, namely, a roentgenogram of the right wrist, a mental test score, eleven anthropometric measurements, an inspection for pubescent signs and anomalies, and a medical diagnosis. A facsimile¹ of the front cover of the folder which was used for each subject is shown in Figure 1. The data were recorded in the appropriate blanks and the roentgenogram was kept in the folder. The mental test record made it possible to check the class to which the subject belonged. All subjects had been given either the Binet or Kuhlmann test within the last five years. The staff psychologists at both institutions retested more than one hundred subjects each in order to make possible a satisfactory mental classification.

The time of the measurements.— It is well known that there are seasonal variations in the growth of children. It was impossible to distribute the measurements over the four seasons in order to allow for fluctuations. The first measurements were made in February 1932 and the last subjects were obtained in February 1933. Two groups were measured in March 1932, while more than 300 subjects were measured in July 1932. Thus, the two opposite extremes, summer and winter, were fairly well represented. The measurements were made during the middle hours of the forenoons and the afternoons. The subjects had to be given ample time before and after each meal on account of the difficulties in getting them from place to place about the institution. It is possible that the time of the day and the seasonal fluctuations have had some influence on the results, however, time and seasonal variations were distributed relatively equally in all age groups.

Techniques Employed

This investigation makes no attempt to develop new techniques. Methods which are already in use have been applied to a new set of data in order to answer certain questions concerning the growth of mentally deficient males. Two types of analysis, skeletal and anthropometric, have been made. The use of these two methods in collecting and interpreting the data will be explained.

Taking the roentgenogram.— A 5" x 7" roentgenogram was made of the right wrist of each subject, with the dorsal side of the hand nearest the

¹ The abbreviations K. V. and M. A. in the second line refer to kilovoltes and milliamperes, respectively.

Name _____ Birth Date _____ Age _____
 Film No. _____ Exposure: K.V. _____ M.A. _____ Time _____ Date _____
 Screen _____ By _____ Institution _____

RADIOGRAPH RECORD

Radius.....	
Ulna.....	
Naviculare.....	
Lunatum.....	
Triquetrum.....	
Pisiforme.....	
Majus.....	
Minus.....	
Capitulum.....	
Hamatum.....	
Total Area.....	
Quad. Area.....	
Ratio.....	
Inspectional Age ..	

Observations: _____

MENTAL TEST RECORD

1. _____	Date _____
Score _____	M.A. _____ IQ _____
2. _____	Date _____
Score _____	M.A. _____ IQ _____

PHYSICAL MEASUREMENTS

Standing Height.....	
Sitting Height.....	
Arm Span.....	
Weight.....	
Chest Girth.....	
Chest Depth.....	
Chest Width.....	
Hip Width.....	
Head Length.....	
Head Width.....	
Head Height.....	

Pubescent Signs _____

Race _____

ANOMALIES OF DEVELOPMENT

Eyes _____
 Skin _____
 Hair _____
 Fontanel: A _____ P _____

MEDICAL DIAGNOSIS

Class: A _____ B _____ C _____ D _____

Figure 1.- A facsimile of the front cover of the folder used to assemble the data for each subject.

TABLE II

THE DISTRIBUTION OF THE SUBJECTS STUDIED
ACCORDING TO THEIR NATIONALITY

	Class A			Class B			Class C			All Classes		
	Number of Subjects	Per Cent of All	Per Cent Answering	Number of Subjects	Per Cent of All	Per Cent Answering	Number of Subjects	Per Cent of All	Per Cent Answering	Number of Subjects	Per Cent of All	Per Cent Answering
American	119	61	76	191	66	77	179	57	78	489	61	77
Pole	5	3	3	11	4	5	14	4	6	30	4	5
German	6	3	4	10	4	4	9	3	4	25	3	4
Italian	5	3	3	5	2	2	10	3	4	20	3	3
Jewish	4	2	3	4	1	2	3	1	1	11	1	2
Hungarian	3	2	2	4	1	2	2	1	1	9	1	1
Austrian	1	1	1	4	1	2	2	1	1	7	1	1
Lithuanian	4	2	3	0	0	0	1	0	0	5	1	1
Swedish	2	1	1	2	1	1	1	0	0	5	1	1
All Other	8	4	5	16	6	6	10	3	4	34	4	5
No Answer	38	19	-	42	15	-	85	27	-	165	21	-
Total	195	101	101	289	101	101	316	100	99	800	101	100

tube and the center of the carpal area perpendicular to the source of the rays. The subjects were seated so that the palmar side of the hand came in direct contact with the film holder and the wrist was in an unflexed position. The objective was to obtain clear shadows of the carpal bones and at the same time to secure a roentgenogram which showed the thickest dimensions of the ulnar and radial shafts. All roentgenograms were made with the assistance of a staff physician. The exposure time varied from one to three and one-half seconds, depending upon the machine used and the size of the hand. Eastman X-ray Exposure Holders were used for all subjects. A second exposure was made for any subject who failed to keep his hand in the proper position. Roentgenograms were inspected carefully to determine which individuals needed additional exposures. A very small number of films were spoiled by movement.

The film was placed at a distance of twenty inches from the source of the rays in order to make the area of the shadows comparable with those on the roentgenograms which the writer had obtained from Laboratory School boys.¹ The print in Figure 2 was made from a roentgenogram obtained with an eight-year-old subject.

The ossification ratio.—A description of the ossification ratio as developed by Carter² has been published. The essential features of his techniques will be explained. The ossification ratio, which is intended to serve as an index of skeletal maturity, is the ratio between the total ossified area in the carpus and the area of the carpal quadrilateral. The

¹ Laboratory School as used throughout this study refers to The University of Chicago Laboratory School.

² Carter, *op. cit.* Freeman and Carter, *op. cit.*



Figure 2.- A print from a roentgenogram of an eight-year-old boy.

carpal quadrilateral has been described as follows: from the upper and outer point on the distal end of the ulnar shaft, to the outer point on the proximal end of the fifth metacarpal, to the nearest point on the epiphysis at the base of the first metacarpal, to the upper and outer point on the distal end of the radial shaft. These four points are designated by faint white dots in Figure 2. The quadrilateral was selected as a correction for hand size. The ratio is, therefore, a pure number which makes it possible to compare individuals directly with respect to their skeletal development.

Roentgenograms were illuminated by a specially constructed light box for purposes of measurement. Complete illustrations and descriptions of the equipment have been presented by the writer in a separate monograph. The writer has been measuring roentgenograms by the Carter technique for three years. The results obtained for mentally deficient boys should be comparable to the Laboratory School's roentgenographic records.

Skeletal-months evaluations.- A qualitative scale for determining the

degree of carpal ossification has been published recently by the writer.¹ Tentative standards have been selected from age to age from birth to maturity. Each age standard has been carefully described. The objective has been to present a carpal scale which may be used somewhat analogous to a handwriting or composition scale. The method is not new. A similar technique and descriptions of age standards have been presented in the White House publications on child development.²

Roentgenograms in the present study have been compared with norms for Laboratory School boys. Each roentgenogram was given a rating in skeletal months according to the degree of carpal ossification which it showed. These ratings made it possible to compare individuals and groups with Laboratory School boys.

Anthropometric measurements.— The eleven anthropometric³ measurements which were made are listed on the form in Figure 1 under Physical Measurements. The technique used in making these measurements is the same as that described in detail by Gray and Ayres.⁴ The writer used a steel instead of a linen tape in order that frequent disinfections could be made. All measurements are net, since they were made without clothing. The metric system has been used because the major studies which are useful for comparative purposes have been reported in metric units.

The instruments used for the measurements were as follows: a double meter stick, a head square, and a bench were used for the measurement of standing height, sitting height, and arm span; chest girth was taken with a steel tape; chest depth, chest width, and hip width were measured with a large sliding calipers; head length and width were measured with a small spreading calipers; and head height was determined by a metal head spanner of the Todd pattern. All of these instruments are mentioned by Gray and Ayres.⁵ Baldwin has given illustrations of the various anthropometric instruments and their use.⁶

Methods of interpretation.— The data of the study have been treated statistically in order to determine averages and the spread for each of the skeletal and anthropometric variables considered. Growth curves have been constructed to compare the characteristics of growth among mentally deficient boys with the physical development of more intelligent males. Skeletal development of the carpal bones has been compared with that of the Laboratory School boys, while growth in length, girth, and size represented in the anthropometric measurements has been compared with that of the private-school boys reported by Gray and Ayres.⁷ There are three reasons for these comparisons. First, the techniques used were identical with those used in the Laboratory School and with those reported by Gray and Ayres. The differences, therefore, should be due to growth conditions and not to

¹ Charles D. Flory, Osseous Development of the Hand as an Index of Skeletal Development. Monographs Society For Research Child Development Vol. I, No. 3, (Study No. 1, Committee Child Development, University of Chicago). Washington, D. C. 1936.

² Growth and Development of the Child; Part IV, Appraisalment of the Child. Report of the Committee on Growth and Development, Kenneth D. Blackfan, Chairman. Section I, Medical Service, White House Conference on Child Health and Protection, Pp. 258-79. New York: Century Co., 1932.

³ Anthropometric measurements are used throughout this study to mean those measurements of body size which were made directly upon the subjects. The carpal measurements are the size of shadows on a film rather than the actual size of the carpal bones.

⁴ Horace Gray and J. G. Ayres, Growth in Private-School Children, Chapter III. Chicago: The University of Chicago Press, 1931.

⁵ Ibid.

⁶ Bird T. Baldwin, Physical Growth of Children from Birth to Maturity. University of Iowa Studies in Child Welfare, Chap. II. Vol. I, No. 1. Iowa City, Iowa: The University of Iowa Press, 1921.

⁷ Gray and Ayres, op. cit.

discrepancies in technique. Second, many of the studies which are based upon large samples of normal children are very old. Third, if there are differences in the growth of children at various levels of mental ability, a comparison of mentally deficient boys with mentally superior boys should reveal the type and the degree of the deviations. An absence of comparable data for average children may, therefore, prove to be an advantage in the interpretation of the results.

Limitations of the Data

There are two types of inadequacy which usually show up in a study of growth. First, there are unforeseen difficulties which can not be remedied after the data have been assembled. Second, there are inevitably certain types of data which are desirable but unavailable. The present investigation has encountered both of these difficulties.

The samples at the various age groups are not sufficient to smooth out the irregularities which arise as a result of the extreme variations found among mental defectives. It was thought that fifty subjects at each age would be adequate to produce relatively smooth growth curves. It has been necessary to remove gross irregularities by smoothing the curves statistically. The samples available for the three classes of mentally deficient boys are inadequate for the construction of growth curves for idiots, imbeciles, and morons as separate groups.

Growth curves from repeated measurements of the same subjects have been considered more significant than the mass method of obtaining data. The time factor has compelled the use of the latter method.

Many subsidiary conditions which may have an influence upon growth had to be treated in an unsatisfactory manner, due to incomplete case histories. It is difficult to obtain information from parents of normal children, and doubly hard to procure data concerning the subnormal population. Illegitimate births and orphaned children complicate the task.

The data very frequently reveal significant differences between mental defectives and normal boys, but the results do not enable the writer to indicate which is cause and which is effect. For example, it is not known whether the mentally deficient boys suffer more illnesses because they are deficient or whether the degree of their deficiency is in part due to the illnesses which they have encountered.

In spite of these limitations, the writer feels that the data are sufficiently adequate to indicate certain trends which seem to be typical of the growth of mentally deficient boys. When the attack on the problem from different angles produces similar results, there is evidence that the deviations found are genuine and not the result of an artifact or a complicated statistical manipulation.

CHAPTER II

SKELTAL GROWTH AS REVEALED BY ROENTGENOGRAMS OF THE CARPAL AREA

Comparative growth studies have frequently expressed the degree and the direction of the deviations in terms of the normal. Age norms are valuable aids to one who desires to give an accurate description of any type of growth. Attempts to evaluate skeletal development have resulted in norms for anatomical age. The x-ray has proved to be a valuable aid in determining the degree of ossification in the various centers of the body. This chapter will be devoted to an analysis of carpal growth of mentally deficient boys. Measurement and inspectional techniques have been employed. Comparisons will be made against age norms expressed as a ratio by one method and as skeletal months by the other.

Rotch considered skeletal changes to be a superior index of physical growth. He recommended that in school grading chronological age should be replaced by anatomical age.¹ Woodrow and Lowell advocated² that anatomical age should be employed as a correction for the errors which arise through the use of chronological age. The White House Conference Committee on Growth and Development suggested³ that the x-ray may be expected to serve as a means for determining the degree of anatomic development as shown in the skeleton. The committee also indicates that childhood environment is likely to leave an imprint upon the skeleton. Woodrow infers from several studies⁴ that anatomical development is correlated with mental ability.

Investigators seem to agree that skeletal growth is a significant aspect of child development. There is perfect agreement that individuals show wide variations in skeletal growth. The present investigation will attempt to indicate the degree of difference between the carpal ossification of normal and mentally deficient boys. This phase of the problem resolves itself into two major aspects: First, changes in the size and complexity of the carpal area which will be evaluated by reference to the ossification ratio and the increase in skeletal months. Second, an analysis will be made of the changes in the variability from age to age.

One would expect mentally deficient children to be relatively immature for their age, if, as Woodrow has suggested,⁵ anatomical development is correlated positively with mental development. It appears, however, that skeletal growth as revealed by carpal ossification should reach maturity at some age for most individuals. It is unlikely that a low mental ability would cause the cartilage to resist calcification. Ossification may progress at a slower rate than the average and continue for a longer time. It may be more rapid than the average and reach maturity at an earlier age. It is possible, but highly improbable, that the rate at which ossification takes place in the skeletons of mental defectives is average or better. What, then, are the characteristics of the carpal development of mentally deficient boys?

¹ Thomas Morgan Rotch, "A Comparison in Boys and Girls of Height, Weight, and Epiphyseal Development," Transactions of the American Pediatric Society, XXII (May, 1910), 36-38.

² Herbert Woodrow and Francis Lowell, "Some Data on Anatomic Age and Its Relation to Intelligence," Pedagogical Seminary, XXIX (March, 1921), 1-15.

³ Growth and Development of the Child: Part IV, Appraisalment of the Child. Report of the Committee on Growth and Development, Kenneth D. Blackfan, Chairman. Section I, Medical Service. New York: Century Company, 1932. Pp. xix + 344.

⁴ Herbert Woodrow, Brightness and Dullness in Children, p. 117. Philadelphia: J. C. Lippincott Co., 1919.

⁵ Ibid.

Prescott reported¹ brief histories for several mentally deficient persons who were also retarded in their carpal development. One case, a female imbecile more than fifty years of age, showed open epiphyses and only four carpal bones. This case can not be considered as typical of the feeble-minded group. Clift found² that mentally deficient children may be either accelerated or retarded depending upon the type of their disorder. The majority of Clift's subjects were known to suffer from glandular disturbances. Glandular disorders are not uncommon in the normal population. Anomalies in development, however, will be treated in a later chapter.

Growth of the Carpal Bones

There are two reasons for using carpal development as a criterion of the stage of skeletal maturity attained at any given age. First, the carpal area contains eight bones which grow at different rates. Second, an x-ray of the hand can be made with a minimum of time, cost, and inconvenience. Each of the carpal bones and the radial and ulnar epiphyses³ were measured according to Carter's technique.⁴ All measurements of carpal size are given in hundredths of a square inch. The mean, probable error of the mean, the smoothed mean, standard deviation, probable error of the standard deviation, and the percentage of the average maximum size are shown for each bone and the two epiphyses in Tables XX to XXIX in the appendix. The growth of individual bones can be depicted best by means of a graph.

The mean size of the carpal bones and the two epiphyses for all ages from five to twenty-four, inclusive, are shown in Figure 3. These curves have been smoothed by the arithmetical method.⁵ If unsmoothed means had been used, extreme cases at several ages would have produced irregularities. It was felt that the small number of subjects at each age justified the use of smoothed curves.

These curves show that the growth rates are different for the various bones. The triquetrum, minus, and ulna have relatively equal increments of growth. The radial epiphysis has a marked positively accelerated growth rate up to age fifteen. There is no decrease in the rate of growth for any bone in the carpal area until age fifteen. The decrease in the rate of growth between fifteen and twenty seems to be less for the hamatum and ulna than for the other bones. The growth trend for the carpal bones is an even or accelerating rate up to age fifteen, a decreasing rate from age fifteen to twenty, with no appreciable gain after the twentieth birthday.

The differences between the carpal development of mentally deficient and normal boys⁶ are shown graphically in Figures 4 and 5. The m. majus and m. minus have been omitted from these figures in order to simplify the graphs. The carpal development of the two groups of boys appears to be very similar in form. The general characteristics of these curves are practically identical. Those bones which show relatively equal increments for normal boys show the same type of growth for defectives. The radius, which has the most positively accelerated growth rate, is positively accelerated in both instances. There are, however, two significant differences. Men-

¹ Prescott, *op. cit.*

² Clift, *op. cit.*

³ Throughout the study the use of the words ulna and radius refer to the epiphyses on the distal end of these two bones.

⁴ Freeman and Carter, *op. cit.*

⁵ Harold O. Rugg, *Statistical Methods Applied to Education*, p. 184. Boston: Houghton Mifflin Co., 1917.

⁶ A monograph by the writer, "Osseous Development of the Hand as an Index of Skeletal Development," contains means for Laboratory School subjects. The comparisons in this chapter are between mentally deficient boys and University of Chicago Laboratory School boys.

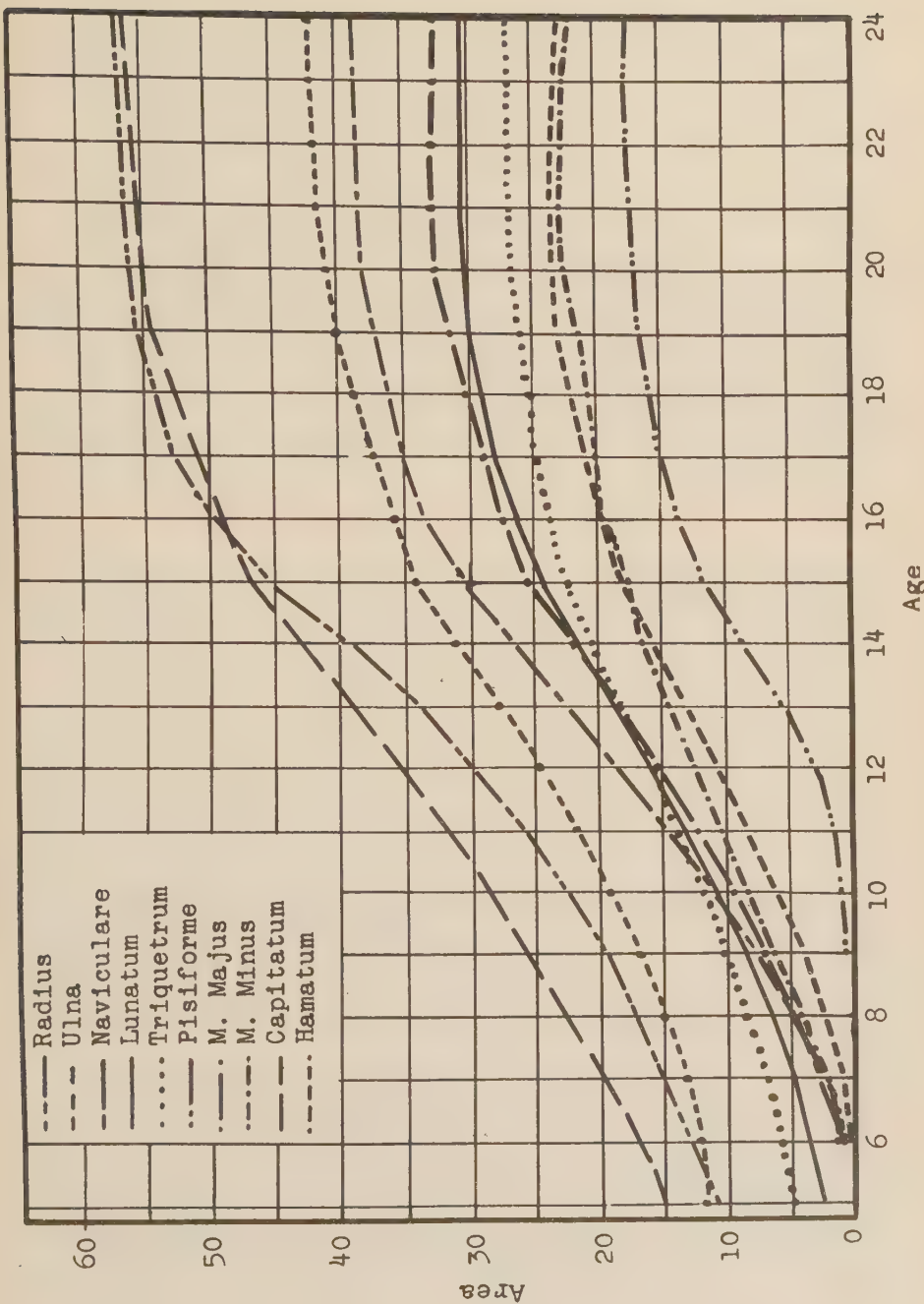


Figure 3.- Smoothed means for the carpal bones and two epiphyses of mentally deficient boys.

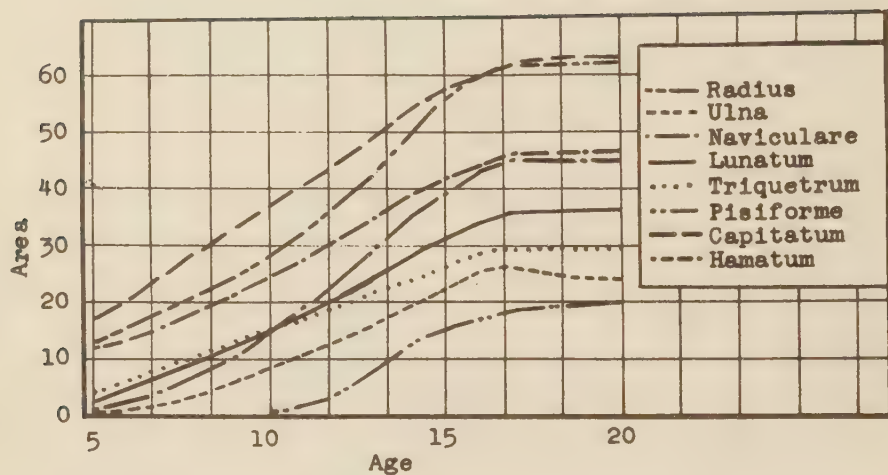


Figure 4.- Six carpal bones and two epiphyses for Laboratory School boys (slightly smoothed).

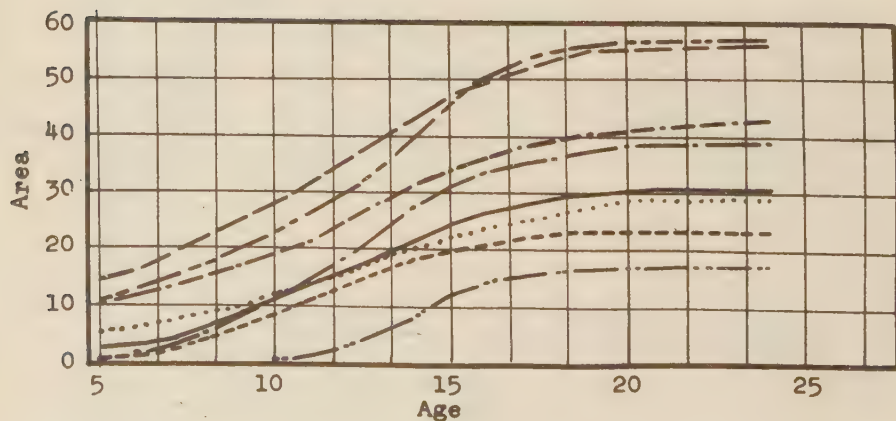


Figure 5.- Six carpal bones and two epiphyses for mentally deficient boys (smoothed).

tally deficient boys never attain the bone size of mature Laboratory School boys. In every instance the maximums are in favor of normal boys. A second, and a more significant difference, is the period of growth. Laboratory School boys have reached their maximum bone size by age seventeen. Carpal bones which have a positively accelerated growth rate for Laboratory School boys show a diminishing rate after age fourteen. Mentally deficient boys maintain their positively accelerated rate one year longer and do not reach their maximum size until age nineteen or twenty. The growth of individual carpal bones shows that defective boys grow at a slower rate, for a longer time, and reach a lower maximum.

The figures which have been presented show that there is a difference in the time of appearance of the carpal centers. Table III shows the percentage of the subjects who have the various bone centers at successive ages. The first appearance of carpal centers seems to be in favor of normal boys, although mentally deficient boys are ahead of the normal with respect to the lunatum and triquetrum at age five. The age at which all subjects show the presence of the various carpal bones does not seem to be greatly different. One boy in the Laboratory School group causes great delay with respect to the development of the naviculare, pisiforme, and minus. The differences appear to be more a matter of growth rate and ultimate size than a question of the time of the appearance of the bone nuclei, although the slight advantage in the appearance of the bones is in favor of the Laboratory School group.

The Ossification Ratio as an Index of Growth

The ossification ratio as developed by Carter was intended to serve as an index of anatomical development. The ossification ratio is based upon the sum of the area of the individual bones and hand size, referred to as total ossification and quadrilateral area, respectively. The basic tables for these variables have been placed in the appendix. The growth of the total area, hand size, and the ratio is shown in Figures¹ 6 and 7. Total ossification equals the size of the carpal quadrilateral just prior to age fifteen for mentally deficient boys. The same degree of development is achieved one year earlier by Laboratory School boys. The quadrilateral area shows a little more positive acceleration for mentally deficient boys than for Laboratory School boys. The difference in total ossification is slight at age five but becomes greater and greater from age to age until Laboratory School boys have reached their maximum. Mentally deficient boys continue to grow until age twenty. Therefore, the subnormal group gains on the normals between seventeen and twenty. The difference between the maximum ossified areas is approximately one-half of a square inch. The quadrilateral area reaches its maximum at age nineteen for defective boys, which is approximately two years later than for Laboratory School boys. The decrease in quadrilateral size for both groups at the older ages is probably due to the difficulty in locating the points on the roentgenograms of mature subjects.

The ratio development is shown for the two groups in Figure 7. These two curves appear to be nearly parallel from ages six to sixteen, inclusive. Ratio values for these two groups are, 35 and 33 at age six, 60 and 55 at age nine, 85 and 80 at age twelve, and 1.06 and 1.01 at age fifteen. These differences in terms of age norms are between one-half and three-fourths of a year at ages nine and twelve. Laboratory School boys are one full year ahead of mental defectives at age fifteen, as was pointed out from growth curves for the quadrilateral and total area. The greater deviation beyond age fifteen is due to the difficulty in locating the points of the quadrilateral. It is very improbable that the quadrilateral area

1 The means used in these curves are the smoothed values obtained from the basic tables in the appendix. The Laboratory School means were taken from a manuscript by the writer: "Osseous Development in the Hand as an Index of Skeletal Development."

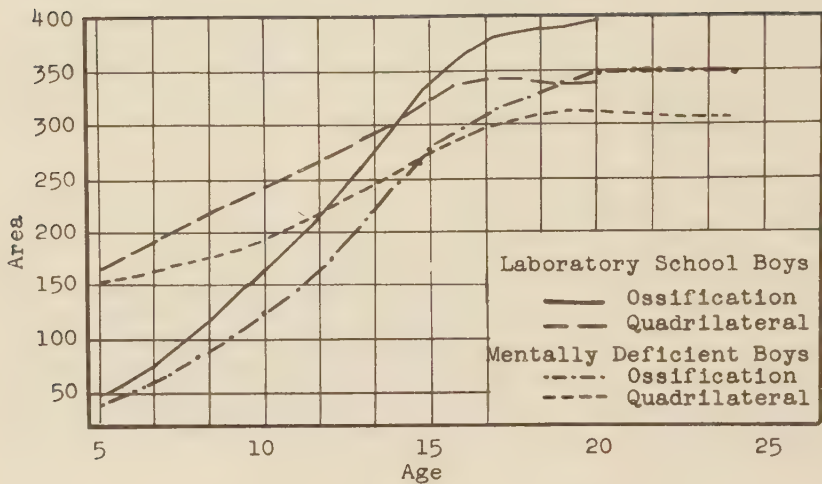


Figure 6.- The total ossification and quadrilateral area for Laboratory School and mentally deficient boys.

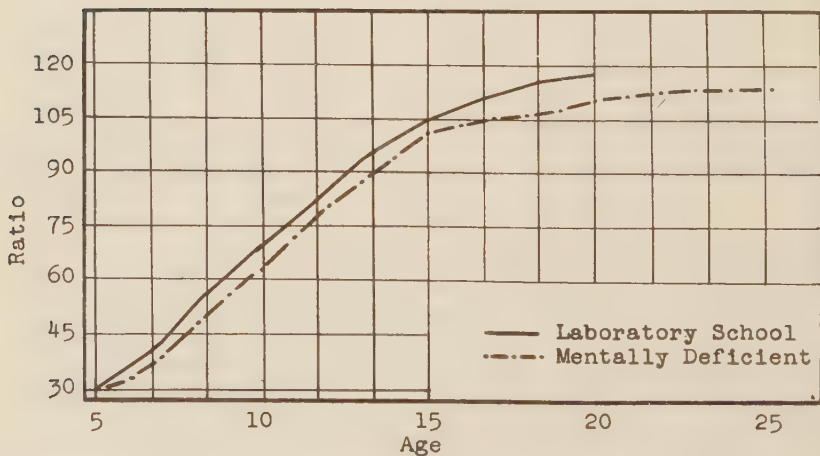


Figure 7.- The ossification ratio for Laboratory School and mentally deficient boys.

TABLE III

THE PERCENTAGE OF NORMAL AND DEFECTIVE BOYS WHO SHOW THE PRESENCE OF THE VARIOUS CARPAL CENTERS

Carpal Centers	Age											
	5	6	7	8	9	10	11	12	13	14	15	16
Ulnar Epiphysis												
Normal	7	27	59	82	98	100						
Defective	0	14	43	73	83	100						
Naviculare												
Normal	34	51	75	92	99	99	100					
Defective	0	43	70	87	94	100						
Lunatum												
Normal	64	87	98	99	100							
Defective	86	71	100									
Triquetrum												
Normal	84	93	100									
Defective	100											
Pisiforme												
Normal	0	0	0	2	6	22	28	66	95	99	99	100
Defective	0	0	0	3	11	24	35	55	87	98	100	
M. Majus												
Normal	33	51	72	88	96	97	100					
Defective	14	36	70	87	100	98	100					
M. Minus												
Normal	9	48	81	95	100	99	100					
Defective	0	21	78	93	100							

actually decreases. A decreasing quadrilateral area produces a rising ratio when maturity might be expected. Growth curves for the individual carpal bones showed that there is a difference in the time when the two groups reach their maximum carpal development. Mentally deficient boys never reach the ratio maximum attained by the more favored boys, but the general difference in development is clear. Mental defectives whether judged by the growth of individual bones or by changes in ratio reach skeletal maturity at a later age than do Laboratory School boys.

Skeletal-Months Evaluations as an Index of Growth

Each roentgenogram was given a skeletal rating by comparing it with the age standards for Laboratory School boys. Means in skeletal-months evaluations were determined for each age group. These means and the variability of these ratings are given in the appendix. Average skeletal-months ratings for Laboratory School boys are the same as their chronological ages because the standards were selected to represent the average Laboratory School boy at each successive age.

The curves in Figure 8 show the differences between Laboratory School and mentally deficient boys in skeletal months. The degree of deviation increases with age until Laboratory School boys have reached maturity. Mentally deficient boys continue their growth over a greater number of years. There were a few subjects who had not reached maturity in skeletal development at the ages twenty-one, twenty-two, and twenty-three. All of the subjects observed had reached maturity in carpal development by their twenty-fifth birthday. Fifty adult idiots were x-rayed as a control group to determine whether immaturity existed at the adult level. There were no signs of skeletal immaturity in any subject who had exceeded his twenty-fourth birthday. These data seem to indicate that mentally deficient individuals do complete their skeletal growth. They reach a state of maturity

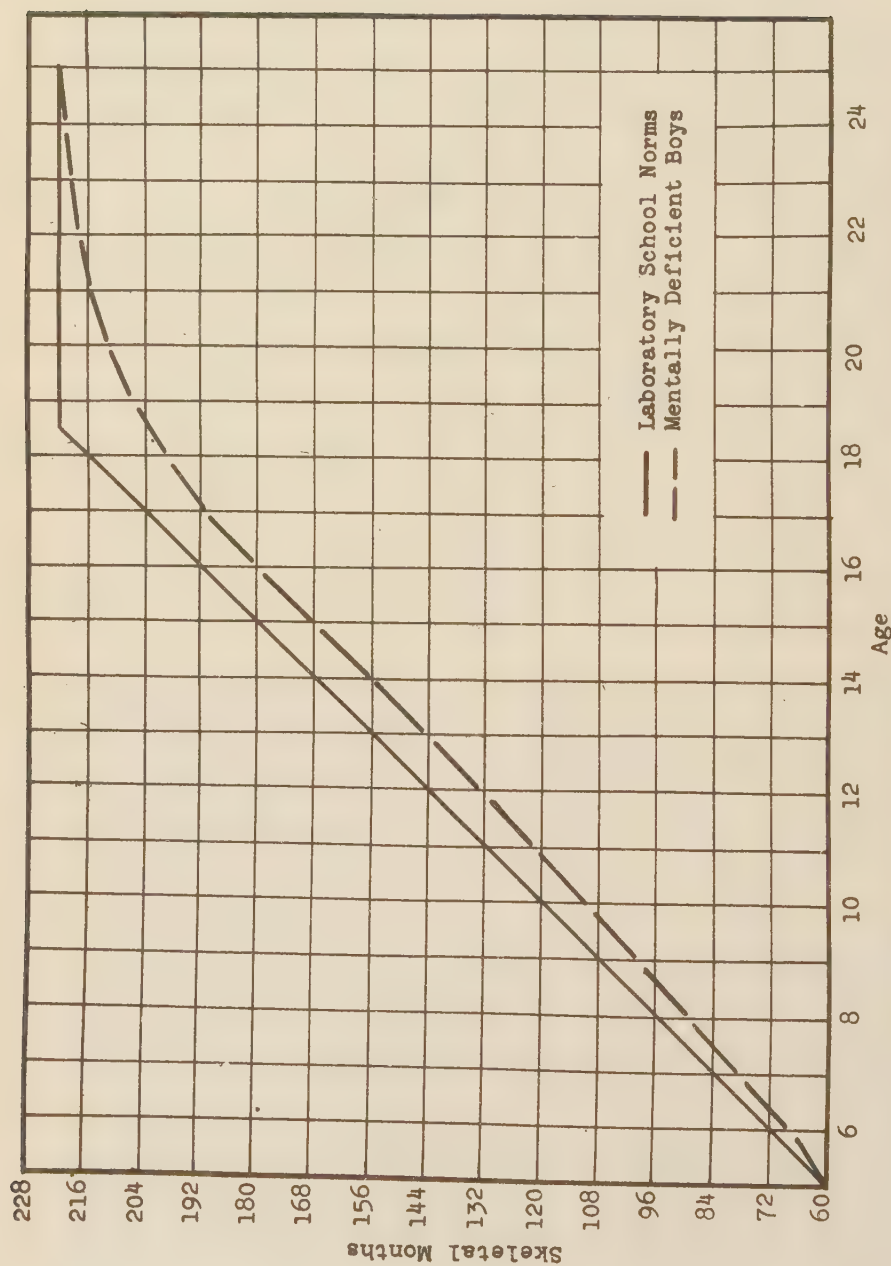


Figure 8.- Carpal ossification of mentally deficient boys when rated in skeletal months.

but their rate of growth is slower, hence immaturity consumes a greater proportion of their life span.

The Variability in Skeletal Growth

The fact that individuals progress at different rates toward maturity and that the larger individuals are earliest to reach their maximum causes the variability in physical measurements to increase with age until the most accelerated approach or reach their ultimate size. The points at which the variability ceases to increase are crucial marks in an analysis of physical growth. This phenomenon is quite valuable for purposes of comparison. The variability of mentally deficient boys will be compared with the variability of Laboratory School boys in skeletal growth.

Standard deviations and their probable errors are given in the appendix for each of the variables used to study carpal development. There is considerable fluctuation in the variability from age to age. The general trend, however, is upward until the late teens, after which a decrease can usually be observed. The magnitude of the variability in carpal development will be illustrated by reference to certain bones, the quadrilateral and total areas, the ossification ratio, and skeletal-months evaluations.

The variability for the radius and the minus has been presented in Figures 9 and 10, respectively. The standard deviation for the radius continues to increase with both groups until age fourteen. There is a definite decrease in the curve for Laboratory School boys after age fourteen. A similar decline does not take place with mental defectives until after age twenty-one. Laboratory School boys have the greatest variability for the minus at ages fourteen and fifteen, while subnormal subjects show an increasing variability until age twenty. The decline in the standard deviation of the minus for mentally deficient boys is very pronounced after age twenty. These data suggest an increasing variability among mentally deficient subjects to approximately twenty years of age, while Laboratory School boys seem to reach their peak in variability four or five years earlier. Further evidence needs to be presented to support this hypothesis.

The variability of the total ossification and the quadrilateral areas is presented in Figures 11 and 12. These curves show that normal boys reach their greatest variability at age fourteen, while the defective group continues to become more diverse until approximately twenty years of age. The two groups do not seem to differ significantly in variability during the early years. The ultimate variability should be only that which is due to the difference in the size of mature adults. It is impossible to tell from these data which group is the more heterogeneous in adulthood.

Standard deviations for the ossification ratio and skeletal-months ratings are presented in Figures 13 and 14, respectively. The two groups of boys reach their peak in variability of the ratio at the same age, but the rapid decline in the standard deviation occurs later for mentally deficient boys. The subnormal group shows an approximately even variability for the ratio between the ages of fourteen and nineteen, while Laboratory School boys have reached their greatest homogeneity by the age of nineteen.

Laboratory School boys show a relatively regular standard deviation in skeletal-months ratings until age sixteen when a marked decrease in variability begins. Mental defectives increase in variability of skeletal-months ratings until age sixteen. A marked decrease in the standard deviation begins at age nineteen, which is three years later than the appearance of the same condition among Laboratory School boys. Skeletal-months ratings are unlike other physical measures, since they reach zero variability at maturity. Nearly all Laboratory School subjects are mature at twenty, while mentally deficient subjects do not reach 100 per cent maturity until age twenty-five.

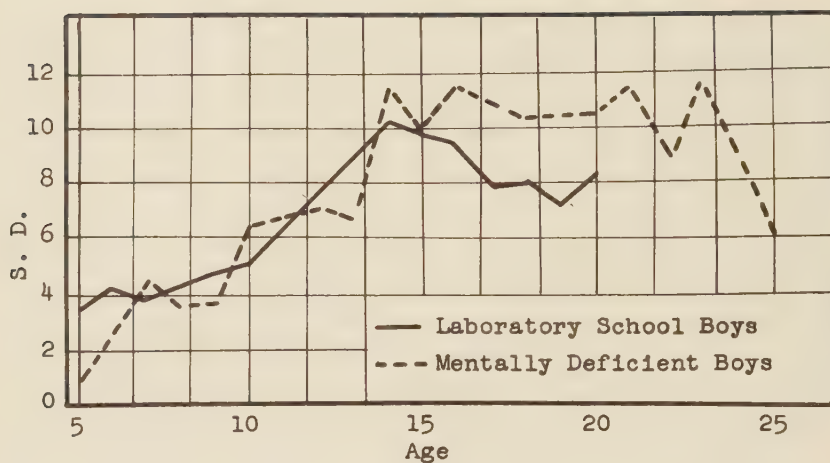


Figure 9.- The variability of the radial epiphysis for Laboratory School and mentally deficient boys.

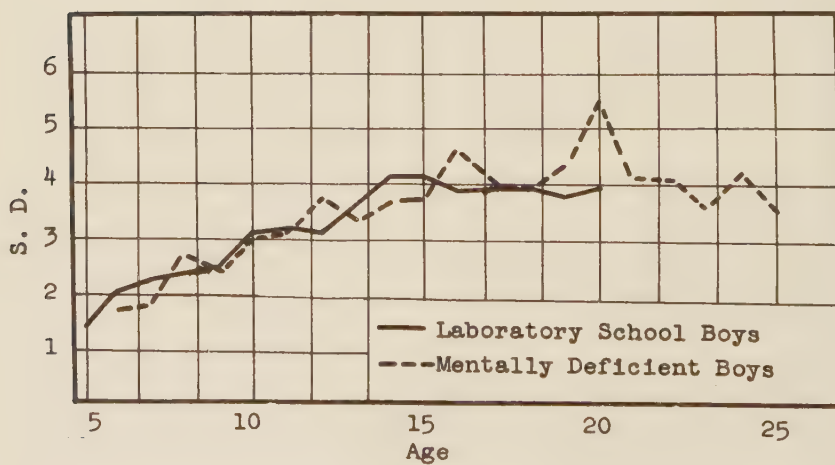


Figure 10.- The variability of the minus for Laboratory School and mentally deficient boys.

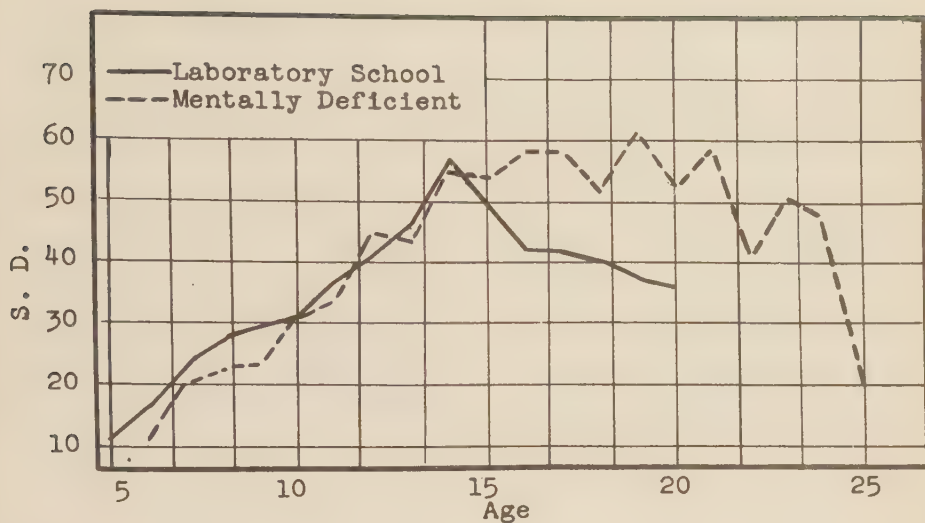


Figure 11.- The variability of the total ossified area for Laboratory School and mentally deficient boys.

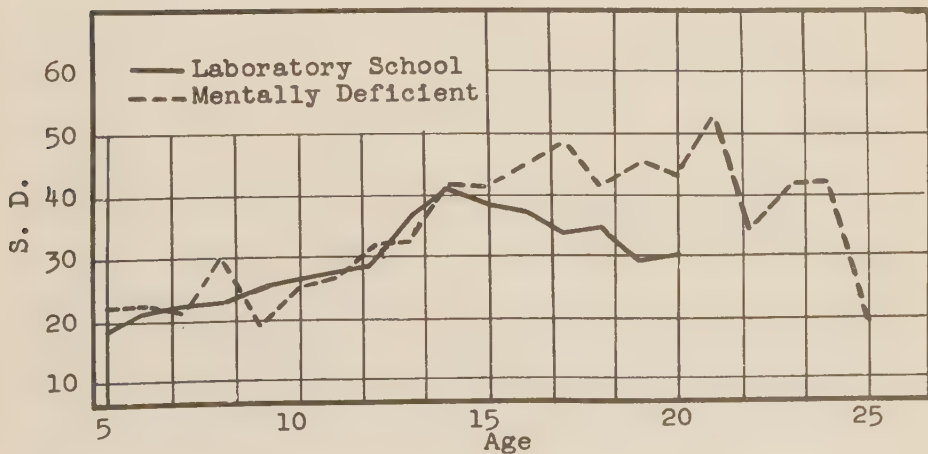


Figure 12.- The variability of the quadrilateral area for Laboratory School and mentally deficient boys.

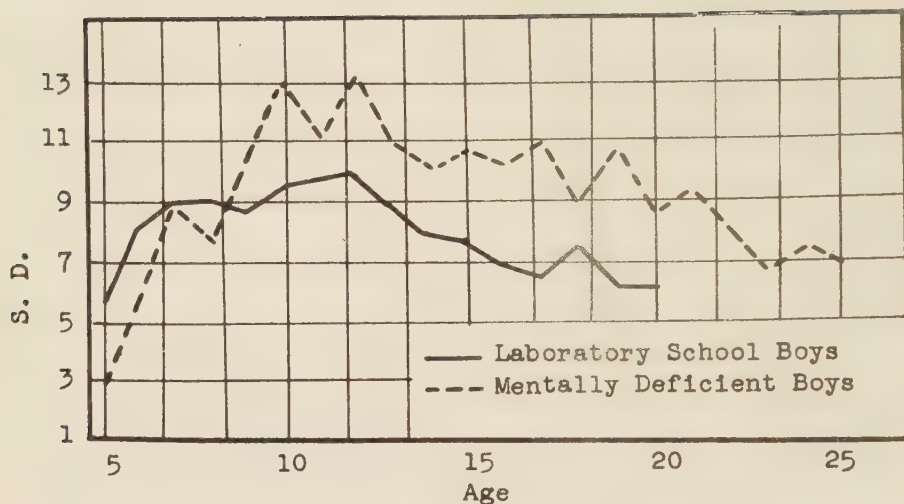


Figure 13.- The variability of the ossification ratio for Laboratory School and mentally deficient boys.

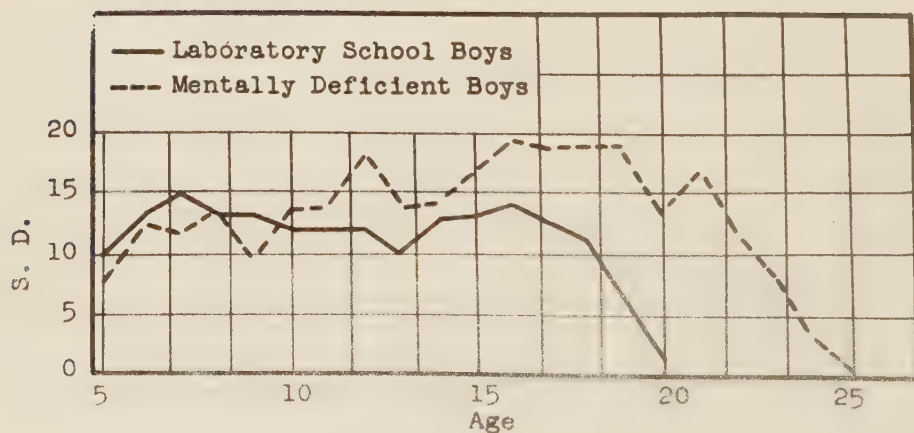


Figure 14.- The variability of maturity in skeletal months for Laboratory School and mentally deficient boys.

The variabilities indicated in Figures 9 to 12, inclusive, are not as much different in absolute size as they are in the time at which the two groups reach their greatest variability. Measurements show that mental defectives have smaller skeletons than Laboratory School boys, therefore, if the variability were expressed in relation to the size of the means, the sub-normal group would have a greater relative variability. Ossification ratios and skeletal-months ratings, Figures 13 and 14, which are absolute measures because both eliminate the effect of size, show that mental defectives are more variable than Laboratory School boys.

These data show that mentally deficient boys have a slower skeletal growth rate than normal boys. Their period of growth extends over a greater number of years. The evidence seems to indicate that the average mentally deficient boy reaches maturity approximately at age twenty, while Laboratory School boys have practically ceased to grow skeletally by age seventeen. The continued increase in the variability of mentally deficient subjects beyond the peak for normal boys is further evidence in support of the hypothesis of a longer growing period. This question will be kept open until the evidence from other measurements has been presented.

CHAPTER III

AN ANTHROPOMETRIC ANALYSIS OF GROWTH

The accumulation of evidence has conveyed the general impression that mentally deficient children deviate negatively from the normal with respect to their physical development. If the general opinion were established, there is yet another aspect to the problem. The rate of growth and the length of the growth period have not been determined for mental defectives. Some opinion has been expressed, at times rather categorically,¹ to the effect that both the rate and duration of growth are correlated with the level of intelligence. The brightest children according to this line of argument would grow at the most rapid rate and for the greatest number of years. Dull children, on the other hand, would have a slow rate of growth and a short period of immaturity. It is possible that one or both of these hypotheses may be incorrect. The lower levels of intelligence may be found in bodies which continue to grow beyond the normal age for maturity. The rate of growth, however, is not likely to be in favor of the child who has an inferior mental capacity. It is the purpose of this chapter to analyze the physical growth of mentally deficient males as revealed by certain anthropometric measurements.

Standing Height, Sitting Height, and Arm Span

Standing height.— A number of studies² have been made which indicate that mentally deficient children are significantly shorter in stature than the average for their age. Mean anthropometric measurements for the subjects used in this study are given in tabular form in the appendix. A picture of the changes in stature from year to year is shown in Figures 15 and 16. Means for private-school boys³ and Smedley's averages⁴ are given in Figure 15 for purposes of comparison. Many studies have failed to find differences between the height of pupils at two levels of intelligence. It seems obvious that differences between normal individuals and those which are slightly above or below normal would not be very striking. If physical differences exist at all, they should be revealed when two extremes in mental ability are compared. Smedley's means have been used because the children upon which they were based lived in the same geographical area as the two other groups. His subjects, in all probability, did not include many pupils of the class found in the Chicago private schools. The private school was relatively a more popular institution when Smedley did his work than it is at present. His norms are likely weighted in a negative direction, especially at the grade-school level, up to age fourteen.

It is significant that the three curves in Figure 15 are separated at all ages. Mentally deficient boys are most like private-school boys in height at age five, when the difference in millimeters is 75 + 14.03. This difference is statistically significant. Smedley's means for public-school boys show an acceleration in the growth of stature at adolescence. Private-school boys seem to have reached approximately their maximum stature at age eighteen, while mentally deficient boys continue to grow in height until the age of twenty. If more data were available, it is probable that public-school boys would reach their maximum between these two ages. It seems, then, that growth in stature is related to the level of intelligence. The degree of intelligence can not be considered the cause of such a relationship but rather a result of the conditions which produce the differences in height.

¹ Walter Fenno Dearborn, Intelligence Tests, pp. 90-91. Boston: Houghton Mifflin Co., 1928.

² Paterson, op. cit., p. 266.

³ Gray and Ayres, op. cit. The means for private-school subjects used throughout this chapter are given in the work cited.

⁴ Baldwin, op. cit., p. 266.

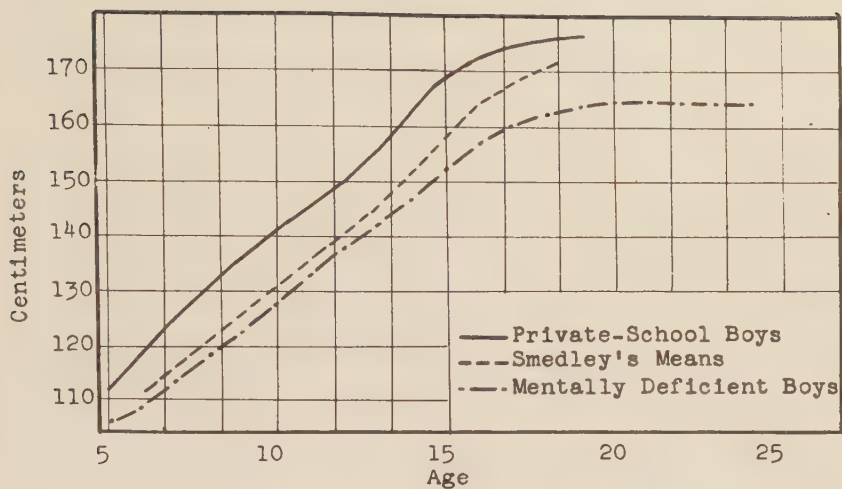


Figure 15.- The growth in height for three groups of boys.

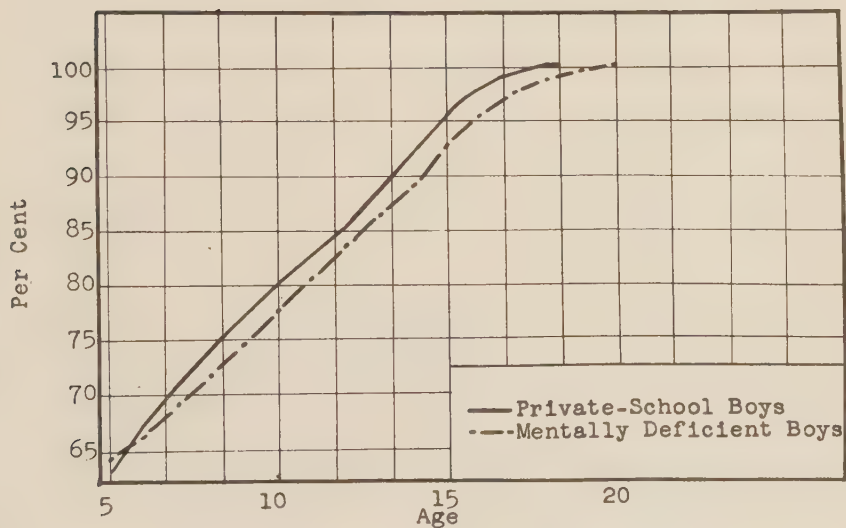


Figure 16.- Growth in stature expressed in per cent of the mean maximum height.

The rate of growth has been expressed in percentage of the average maximum¹ attained at successive ages. Figure 16 reveals the relative growth rates for private-school and mentally deficient boys. The crossing between ages five and six is probably due to the fact that only seven subjects were obtained at age five. The evidence indicates that private-school boys grow at a more rapid rate and reach their adult stature at an earlier age. Mentally deficient boys increase in height at a slower rate, and reach a lower maximum, even though growth continues over a longer period.

Paterson has indicated² that many of the differences found between normal and mentally deficient children were so small that the overlapping in stature approached 100 per cent. Norsworthy found³ that 45 per cent of her subjects were above the median stature for ordinary children. Since the distributions are sufficiently symmetrical the probable percentage of mental defectives below the Smedley and private-school means can be found. The differences between the means were determined. These differences were then turned into standard deviations from the means of the mentally deficient group. The results as presented in Table IV show the differences in millimeters, in sigma values, and the percentage below the Smedley and private-school means. The percentage of mentally deficient boys below Smedley's mean for age twelve is only slightly below the results obtained by Norsworthy. On the other hand, only 19 per cent of the mental defectives are up to the Smedley mean and only 8 per cent reach the private-school average at age eighteen. If age twelve were considered alone the difference might be explained away, but the accumulation of evidence which is all in the same direction seems to justify the contention that mentally deficient boys are on the average shorter than normal and superior boys.

Sitting height.- Sitting height is a measure of length, exclusive of lower limbs. The deviations of mental defectives from private-school boys in sitting height are presented in Figures 17 and 18. The same general trend is revealed as was found with stature. Doll reported that,⁴ "the feeble-minded of all grades are below normal in sitting height." His contention that sitting height is more subnormal for mental defectives than standing height does not seem to be confirmed by the present study. The sitting-height deviations ranged roughly from 5 to 8 centimeters while the differences in standing height varied between 10 and 16 centimeters. Sitting height is approximately one-half of the total stature and the negative deviations are about one-half as large as those for standing height. Figure 18 reveals one slight difference from standing height. Private-school boys do not attain their maximum sitting height until nineteen, which is later than was found for total stature. The gain between eighteen and nineteen is very small. Doll reported that⁵ "the feeble-minded develop at a retarded rate and cease growing at an earlier age." The results as presented in Figures 17 and 18 contradict such statements. These data indicate that mentally deficient boys grow at a slower rate, over a longer period, and attain a lower maximum sitting height.

Arm span.- The span of the arms has been measured in a number of instances but few studies report norms for this variable. Arm span for normal children approximates stature. The notion has been expressed that an arm span which deviates greatly from the stature indicates a pathological condition.

¹ The percentage of the maximum was obtained by dividing the smoothed means at the various ages by the smoothed average maximum stature for the group under consideration. Ages twenty-four and twenty-five were never used as the maximum because the subjects were few at these ages.

² Paterson, *op. cit.*, p. 54.

³ Naomi Norsworthy, "The Psychology of Mentally Deficient Children," *Archives of Psychology*, No. 1 (November, 1906), 1-111.

⁴ Doll, *op. cit.*, p. 52.

⁵ Doll, *op. cit.*, p. 53.

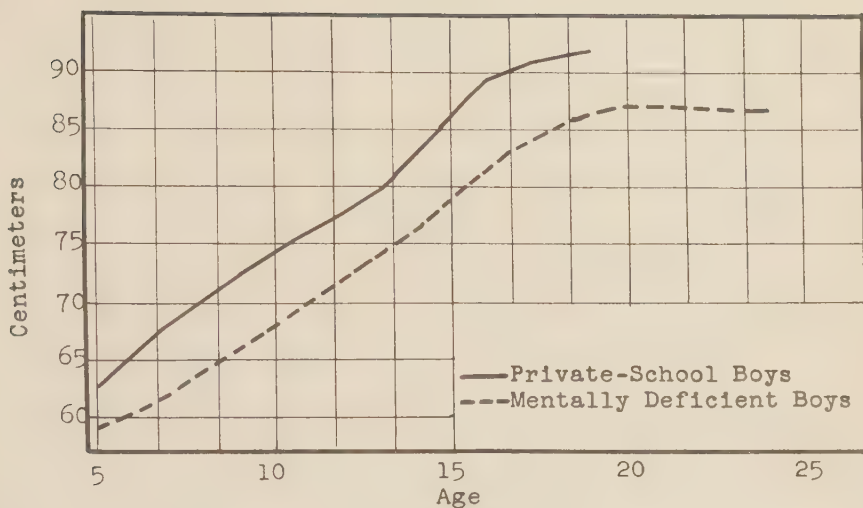


Figure 17.- The average sitting height for private-school and mentally deficient boys.

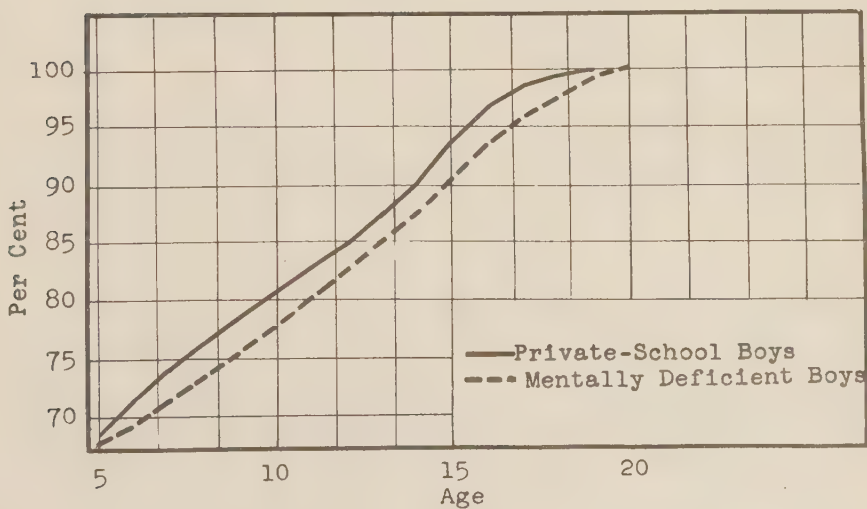


Figure 18.- Growth in sitting height expressed in per cent of the mean maximum sitting height.

TABLE IV

THE DEVIATIONS OF MENTALLY DEFICIENT BOYS IN HEIGHT
FROM TWO OTHER GROUPS OF BOYS

Deviations from the Smedley and Private-School Means	Age				
	6	9	12	15	18
Deviations from Smedley's Means in:					
Millimeters	20	37	18	53	88
Sigma differences ...	.33	.68	.24	.42	.87
Per Cent	63	75	59	66	81
Deviations from the Private- School Means in:					
Millimeters	95	134	134	175	139
Sigma differences ...	1.57	2.45	1.78	1.37	1.38
Per Cent	94	99	96	91	92

The writer was unaware of the dearth of comparable data when this variable was included in the measurements. The evidence from the present study fits into the same general pattern as that for stature and sitting height.

The average arm span for St. Louis¹ boys and mentally deficient subjects is presented in Figure 19. A comparison of arm span and height for the defective group is given in Figure 20. The St. Louis averages may be considered as norms for public-school children. The striking fact in Figure 19 is the consistent superiority of St. Louis public-school boys in arm span, when compared with mentally deficient boys. This finding agrees with the results obtained for stature and trunk length. Porter indicates² that arm span is approximately the same as the height of children. The differences according to his findings are less than 1 per cent from six to eleven and scarcely more than 2 per cent at the later ages. The arm span of St. Louis children became slightly greater than the height as growth progressed. Mentally deficient boys conform as a group to Porter's results in this respect, as can be observed from Figure 20.

Montessori called attention to an opinion which prevailed at one time that long arms indicated a reversion to the anthropoid types.³ Mentally deficient boys, when considered as a group, appear to add no support to such a belief; on the contrary they seem to follow the usual type of development. The maximum arm span attained is below the mature average for St. Louis boys.

Gains in Weight

Weight is a growth variable which has not only wide individual differences but also may have great fluctuations for the same individual. It is apparent that environmental circumstances very rarely bring about an actual reduction in stature. Weight may decline markedly and remain at a low level for a considerable period of time. Fluctuations in weight which have been produced by environmental circumstances have caused investigators to seek other indices of growth, such as the ossification ratio. Considered as a

¹ William Townsend Porter, *The Growth of St. Louis Children*, Transactions of the Academy of Science St. Louis, Vol. VI, No. 12, April 14, 1894. Pp. 263-80.

² *Ibid.*, p. 334.

³ Maria Montessori, *Pedagogical Anthropology*, Translated by Frederic Taber Cooper, p. 74. New York: Frederick A. Stokes and Co., 1913. Pp. xi + 508.

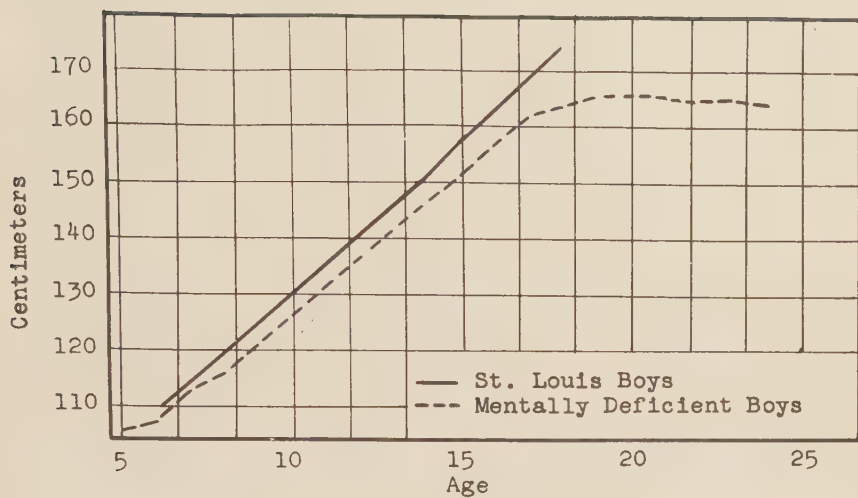


Figure 19.- The average arm span for St. Louis and mentally deficient boys.

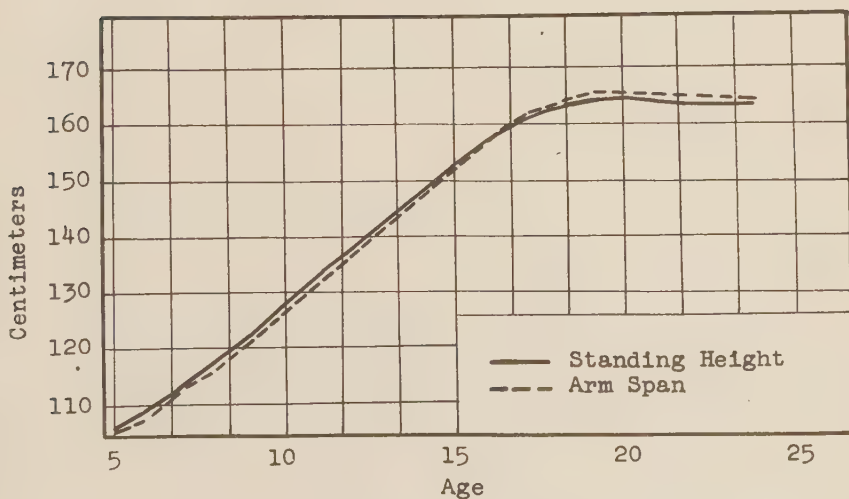


Figure 20.- A comparison of arm span and standing height for mentally deficient boys.

group, children increase in weight from age to age at least until maturity has been reached. The additional avoirdupois which one usually acquires in middle life or after is not the concern of this investigation. Gains in weight from age to age and the percentage of the mean maximum weight attained at any given age can be seen by an inspection of Figure 21. The means for public¹ and private-school boys have been plotted, in Figure 21, for comparative purposes. These curves indicate that the three groups are different with respect to their development in weight. The time at which an individual reaches maturity in weight is hard to determine on account of the increases which occur after other physical variables have ceased to change. Private-school boys and mentally deficient subjects continue to gain in weight up to age nineteen. Age twenty-four may be disregarded since the sample is very small.

Critics may again point to the work of Norsworthy² as evidence for the belief that the overlapping of the distributions for normal and defective children is so great that the differences in weight are insignificant. The same type of analysis can be made as was presented for height. Table V gives the superiority in weight for public and private-school boys when compared with mentally deficient subjects.

These data make it clear that there is a real difference between the three groups of boys with respect to their growth in weight. Norsworthy³ reported that 44 per cent of her subjects exceeded the median for normal children. There is no age at which as many as 30 per cent of the mentally deficient boys equal or exceed the mean of their more favored contemporaries. The difference is much more significant than that found for height. Changes in weight during adulthood make it practically impossible to generalize about the ultimate weight of any of the three groups. The trends suggest strongly that mentally deficient adults are likely to be below the general population in weight. A majority of the studies have shown a superiority in favor of normal children with respect to weight.

TABLE V
THE DEVIATIONS OF MENTALLY DEFICIENT BOYS IN WEIGHT
FROM TWO OTHER GROUPS OF BOYS

Deviations from the Smedley and Private-School Means	Age				
	6	9	12	15	18
Deviations from Smedley's Means in:					
Kilograms	1.7	2.3	3.2	5.0	8.3
Sigma differences ...	1.10	.70	.62	.57	.71
Per Cent	76	76	73	72	76
Deviations from the Private- School Means in:					
Kilograms	4.3	7.1	9.1	14.1	12.8
Sigma differences ...	2.77	2.15	1.75	1.62	1.09
Per Cent	100	98	96	95	76

¹ Baldwin, *op. cit.*, p. 297.

² Norsworthy, *op. cit.*, p. 68.

³ Norsworthy, *Ibid.*, p. 68.

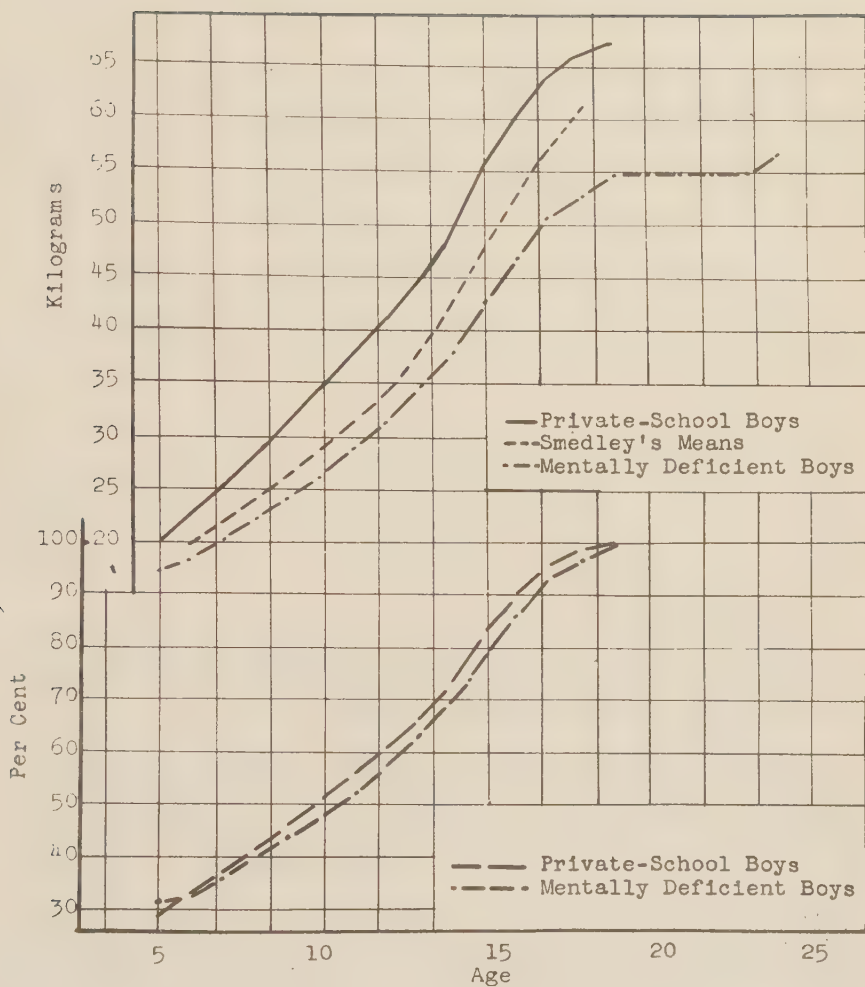


Figure 21.- The average weights for three groups of boys and the per cent of the mean maximum weight for two of these groups.

Chest and Hip Measurements

Chest and hip dimensions have been included in the measurement program of most institutions which are collecting anthropometric data. The writer knows of no widespread attempt to use these measurements in diagnosing or grading pupils. Four measurements, chest girth, chest depth, chest width, and hip width, were obtained for mentally deficient boys as additional evidence concerning the growth phenomena.

Chest girth.- Chest circumference is a measurement which has had rather wide use. Chest girth is frequently used in giving an accurate description of an individual. The connection between lung capacity and chest size is probably one of the reasons for attaching significance to the circumference of the chest. Growth curves for the chest girth of mentally deficient and private-school boys are given in Figure 22. Growth rates in percentage of the average maximum girths are presented in Figure 23.

These curves in Figure 22 give additional support to the contention that mentally deficient subjects are inferior in physical size to the more favored boys of equal age. The chest girth of private-school boys shows an accelerated rate of growth beginning about the time of the onset of pubescence. There is no evidence of such a marked spurt in the growth of the chest circumference of mentally deficient boys.

Mentally deficient boys continue to grow in chest girth at least up to age twenty. It is probable that private-school boys are approaching their maximum at nineteen. Of course, chest girth, like weight, is affected somewhat by the increase in size which comes after the male has reached maturity. These results indicate that mentally deficient boys grow in chest girth at a slower rate, over a longer period of time, and reach a maximum which is below that for private-school boys.

Chest depth and width.- The depth and width of the chest are factors which contribute to the circumference. One might expect these two measurements to be superfluous when chest girth is known. It is possible, however, that the chest development of inferior individuals may proceed somewhat differently than that for private-school boys.

The growth of the chest in depth is shown in size and rate in Figures 24 and 25, respectively. There is a very clear cut and significant difference between mentally deficient and superior males with respect to their chest depth. Mentally deficient boys appear to be relatively flat chested when they are compared with boys who have had the most favorable environmental and hereditary advantages.

The greatest difference in growth rate which has yet been observed is shown in Figure 25. Private-school boys are from 3 to 5 per cent ahead of subnormals in their progress toward maturity. Mentally deficient boys continue to increase in chest depth until age twenty-three. The acceleration in the rate of growth for chest depth among private-school boys, which occurs at age fifteen, has no corresponding point of marked acceleration among the deficient group. The growth curve for mental defectives shows no decline in rate until age eighteen.

The growth of mentally deficient and private-school boys with respect to chest width is shown in Figures 26 and 27. The divergence of the curves in Figure 26 indicates that the differences in chest width are very significant and become increasingly greater from age to age. Mentally deficient subjects seem to have approached their maximum at age nineteen. The accelerated rate of growth in chest width which occurs at age fourteen in private-school boys has not diminished at age nineteen. These data are insufficient to determine the mature chest width for private-school boys. But mentally deficient boys appear to approach their maximum chest width sooner

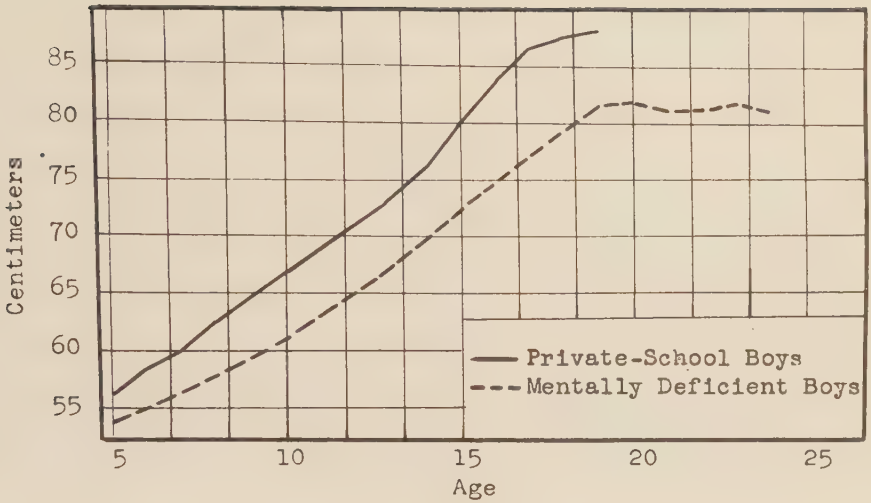


Figure 22.- The average chest girth for private-school and mentally deficient boys.

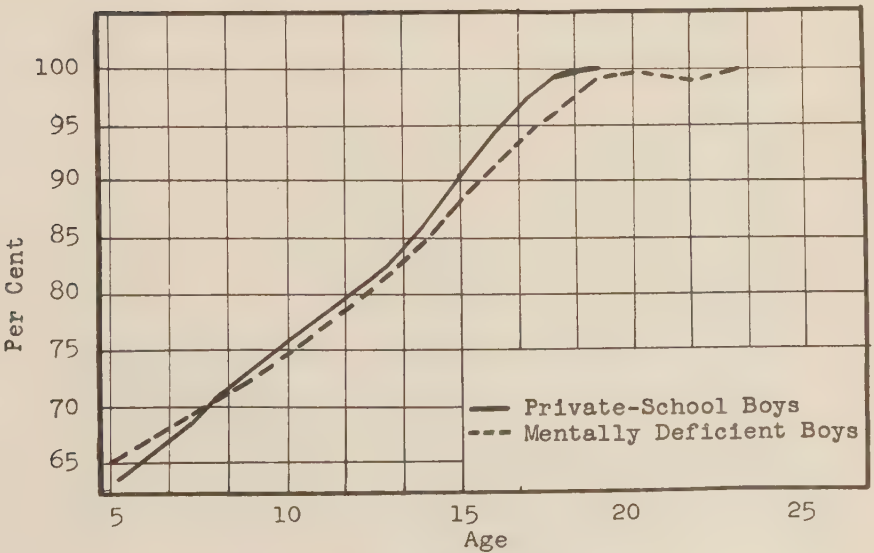


Figure 23.- Growth in chest girth expressed in per cent of the mean maximum chest girth.

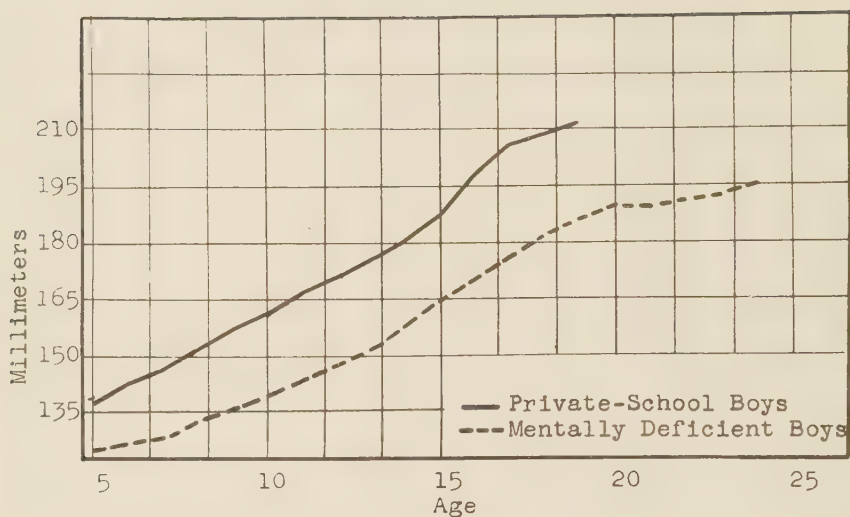


Figure 24.- The average chest depth for private-school and mentally deficient boys.

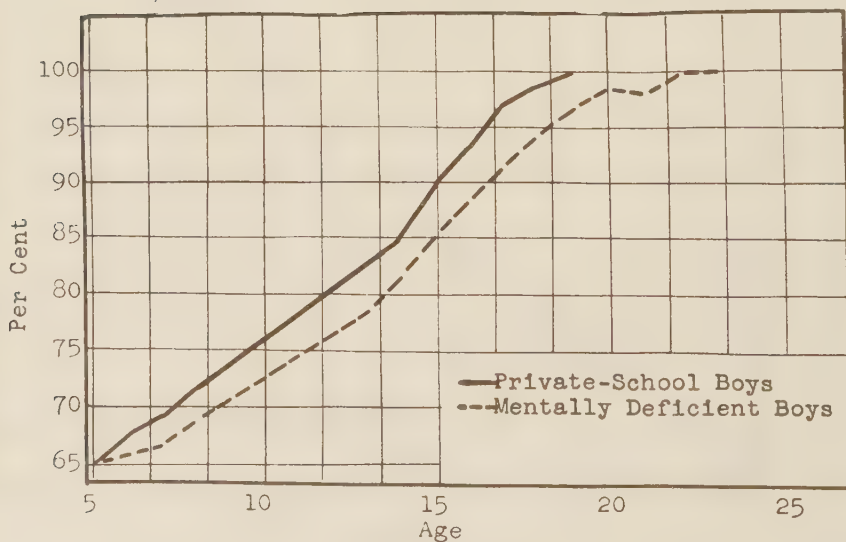


Figure 25.- Growth in chest depth expressed in per cent of the mean maximum chest depth.

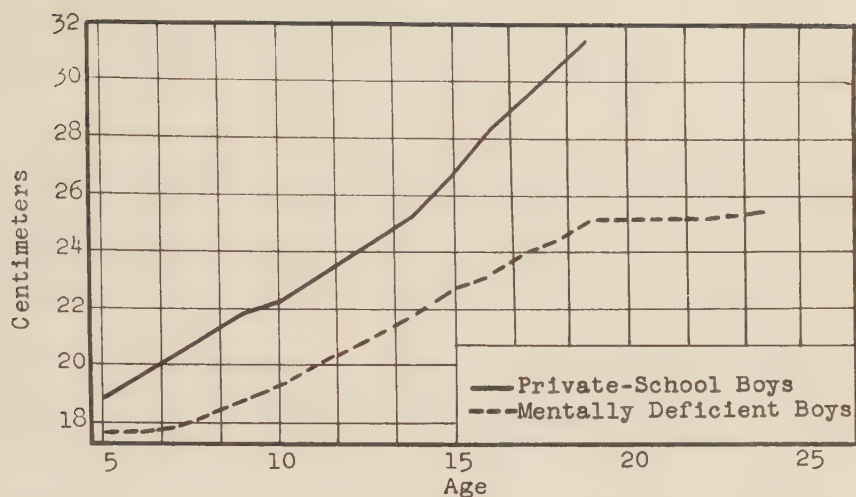


Figure 26.- The average chest width for private-school and mentally deficient boys.

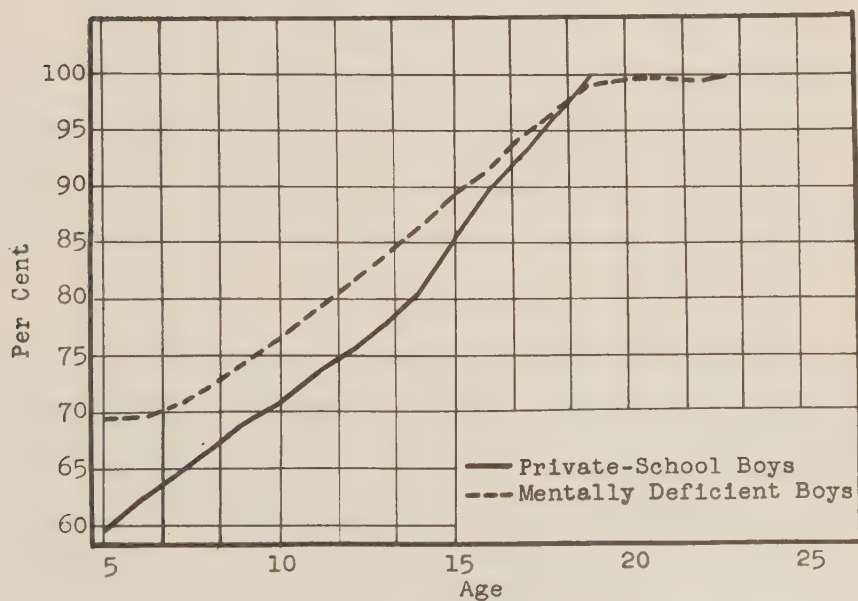


Figure 27.- Growth in chest width expressed in per cent of the mean maximum chest width.

than private-school boys as can be seen in Figure 27. Since the growth rates differ, and private-school boys have not reached their maximum at nineteen, it appears that there is a type of growth exhibited in the development of chest width which has not been found in other anthropometric traits. The growth rate for mentally deficient boys is relatively regular from year to year. Their chest width is practically mature at age nineteen. These data suggest an earlier maturity for mental defectives with respect to the width of the chest.

Hip widths for mentally deficient and private-school boys are given in Figure 28 in comparison with the chest width for the two groups. The growth rate for hip width is shown in Figure 29. The rate of growth and the absolute increments for hip width are in line with the evidence for height, weight, arm span, chest girth, and chest depth. The differences between the two groups of boys in hip width are statistically significant at all ages. The rate of growth is slower for the subnormal group and the maximum hip width is attained one year later among mentally deficient boys.

Measurements for chest depth, chest girth, and hip width lend supporting evidence to the hypothesis that mentally deficient boys are below the more favored classes in size, they require a longer time to attain their mature level, and therefore progress toward maturity at a slower rate. The comparative growth in hip and chest width for the two groups demands further explanation.

The curves in Figure 28 show a rather striking difference in the relationship between chest and hip widths for mentally deficient and private-school boys. Private-school boys are only slightly different in these two dimensions until age fifteen, when there is a rapid increase in their chest width. The most significant fact shown by the curves in Figure 28 is the relatively larger hip width among the deficient group. Chest width never equals hip width after age seven for mental defectives, while with private-school boys chest width equals or exceeds hip width at every age except thirteen. These data suggest a feminine type of body build among mentally deficient males. It is well known that mentally deficient persons do not as a rule participate in vigorous exercise. This condition may exist in part because of their institutionalization, but the state of their physical co-ordination in many instances prohibits participation in strenuous exercise. But it is hard to believe that the consistent superiority of hip width over chest width is due to the lack of exercise or any other environmental condition. This phenomenon may be related to the sexual development among the subnormal group. A tendency toward femininity explains in part the relatively greater hip width among mentally deficient males. This point should be investigated more carefully with types of data which are lacking in the present study.

Head Measurements

After man began to consider the brain as the part of the anatomy which was responsible for thought processes, it was perfectly natural that he should attempt to associate super mental ability with a greater capacity for housing such a potent mechanism. Arguments from analogy suggested that an advanced stage of evolution and more brain capacity were directly associated. The ape has a brain which is inferior to that possessed by man, but superior to the lower forms of mammals. The particular issue in the present study is to determine the difference in the growth of the skull for humans who have been diagnosed as extremely low in mental ability, as compared with private-school boys who are on the upper half of the intellectual scale. Three head measurements, length, width, and height, have been made. Each of these dimensions will be examined.

A comparison of the head size of subnormals with private-school boys in Figure 30 shows that mentally deficient boys are significantly inferior in

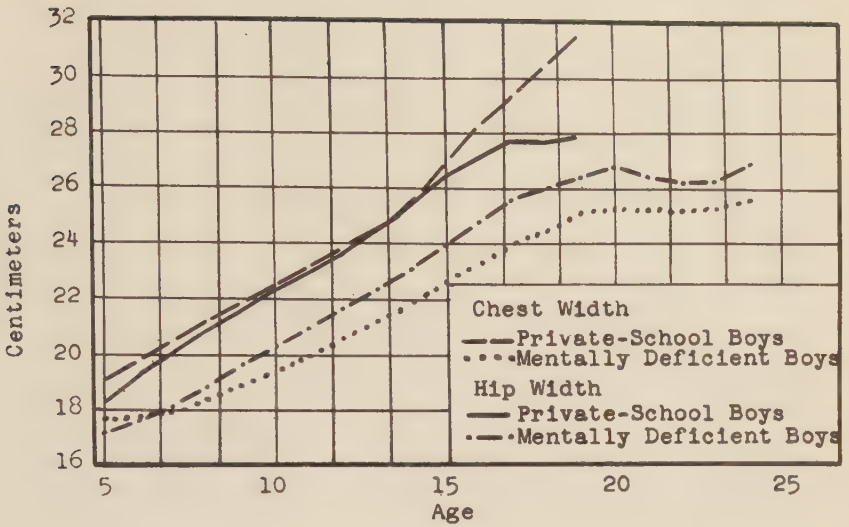


Figure 28.- The average hip width for private-school and mentally deficient boys in comparison with their chest width.

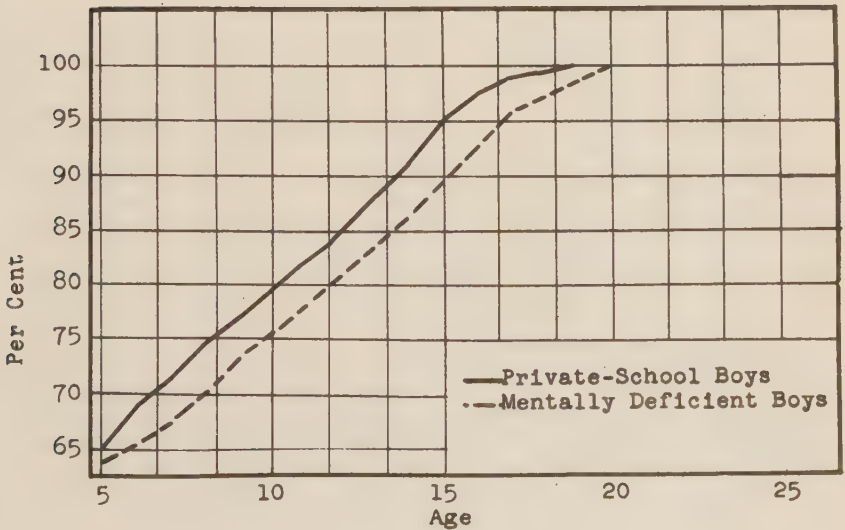


Figure 29.- Growth of hip width expressed in per cent of the mean maximum hip width

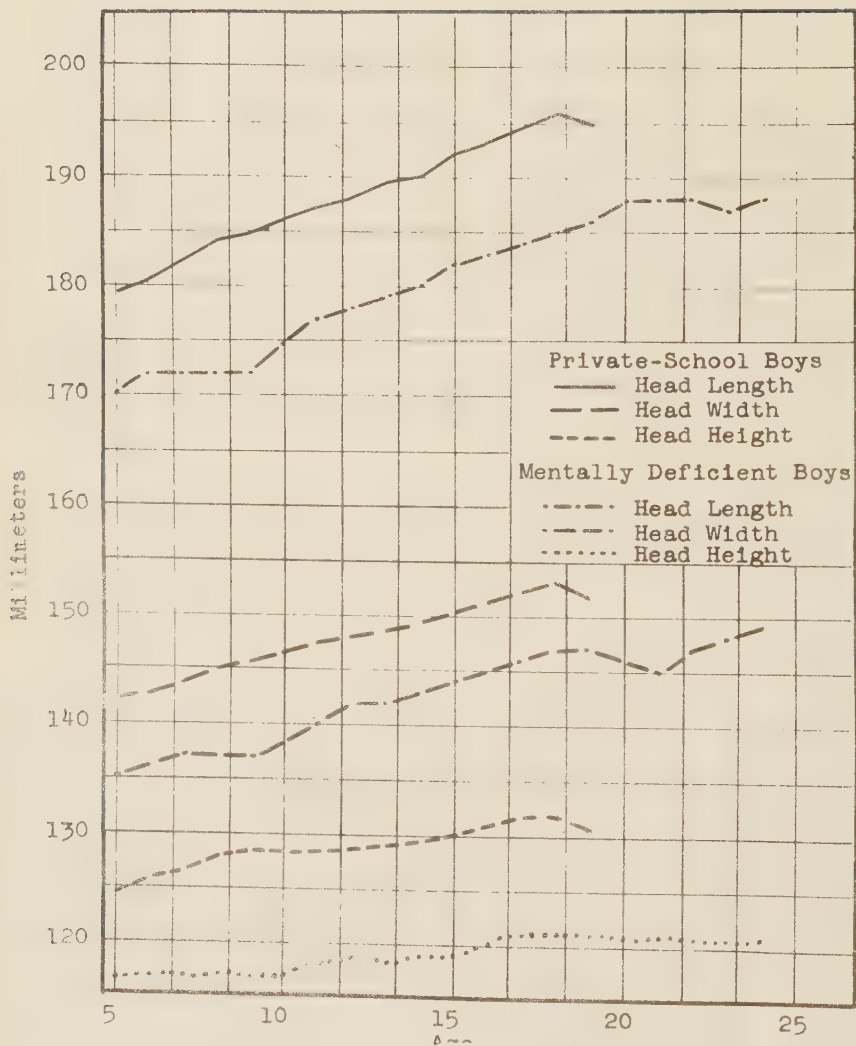


Figure 30.- The averages for head measurements for private-school and mentally deficient boys.

the growth of the skull. The difference in head length at age fifteen, for example, is $10.0 \pm .96$, while differences in width and height are $6.7 \pm .66$ and $11.0 \pm .60$, respectively. In each instance the difference is at least ten times its probable error. These differences are so clear cut that one concludes without hesitation that mentally deficient boys as a group are significantly below private-school boys in all measurements of head size. Of course there are a few cases of hydrocephalus and microcephalus among the deficient class which cause a greater variability among the mentally deficient group. The average private-school boy is approximately one sigma above the mean for mental defectives in head length and width at age fifteen, which indicates that more than 70 per cent of the mentally deficient boys are below private-school averages in head length and width. The mean head height for the subnormal group is 1.73 standard deviations below the mean for private-school males. The chances are that not more than five subjects in one hundred of the fifteen-year-old mentally deficient group will reach or exceed the average head height for private-school boys at age fifteen. The absolute head dimensions of the two groups are clearly different at all ages.

The growth trend for head size, between five and twenty-five, as revealed in Figure 30 does not appear to differ greatly in type for the two groups. The growth rate, expressed in percentage of the average maximum attained at successive ages, is presented in Figure 31. These curves show that both groups of boys have attained more than 90 per cent of their maximum head size at five years of age. The subnormal group has a slower growth rate in both head length and head width. Mentally deficient boys reach their maximum head size at least one year later than private-school boys. Head height is nearer maturity at age five than either the length or the width of the skull. These data constitute additional evidence in support of the hypothesis that mentally deficient males have a slower growth rate, a longer period of growth, and reach a physical maximum which is below the mean for private-school boys.

The Variability of the Anthropometric Measurements

A general notion prevails that mentally deficient persons are much more variable than normal individuals. Doll gave evidence to show that subnormal individuals are quite heterogeneous.¹ It was his interpretation that the amount of variability is related to the degree of the mental defect. Tiraepgui made a study in which particular attention was given to the variability of the feeble-minded.² He found a greater variability among mental defectives but concluded that the differences had only a group significance. His subjects consisted of 200 mentally deficient Jewish children. The overlapping in the two groups studied by Tiraepgui was very great. One weakness in this study of Jewish children is the small age range of the sample. A complete picture can be given only by a survey of the entire growth period.

The variability of height and weight for private-school and mentally deficient boys is given in Figures 32 and 33. The subnormal group is much more variable in stature than the private-school group. The greatest variability in height is reached by the private-school group at age fourteen, while mentally deficient boys show a sharp increase in the standard deviation between fourteen and fifteen. After age fifteen private-school males become much more homogeneous in height, while a similar decrease in the variability among the subnormal group does not occur until after age nineteen.

¹ Doll, *op. cit.*

² Louis A. Tiraepgui, *Comparative Variability in Anthropometric Traits of Normal and Feeble-minded*, Santiago, Chile, 1923, pp. 1-141.

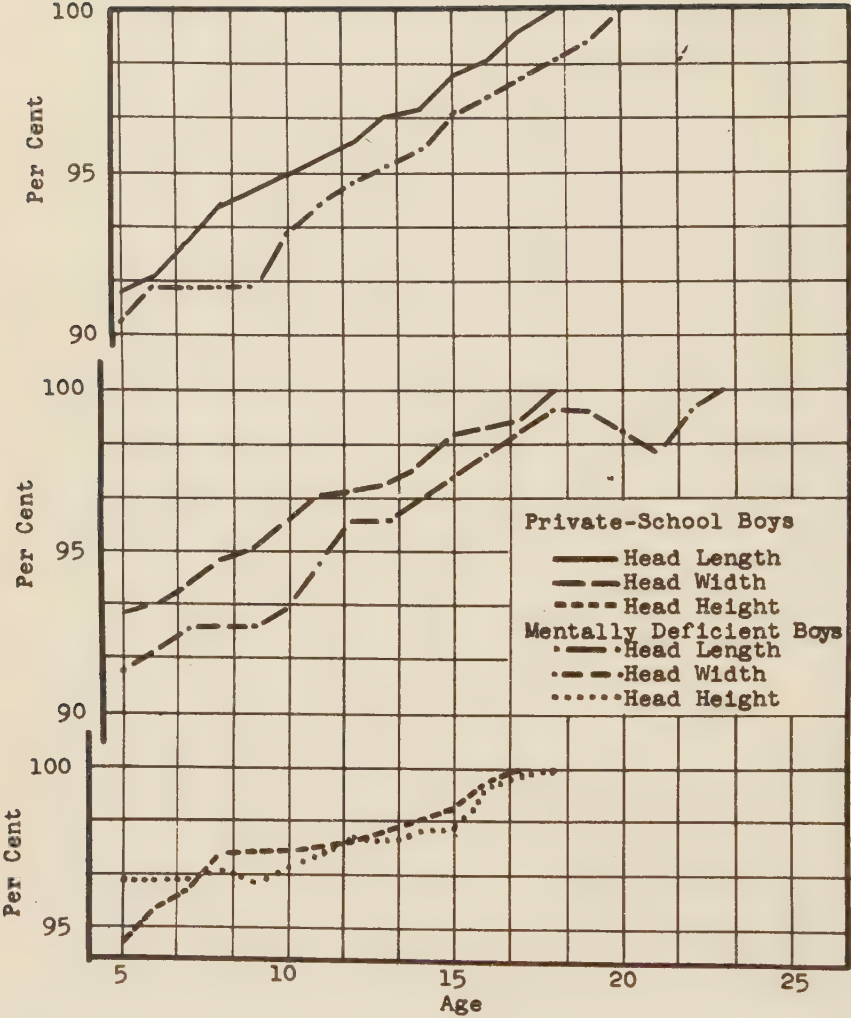


Figure 31.-- The growth in head size expressed in per cent of the mean maximum head measurements.

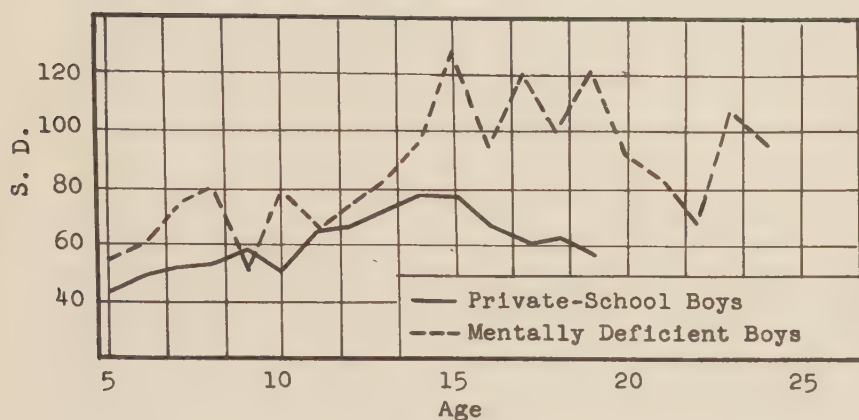


Figure 32.- The variability of height for private-school and mentally deficient boys.

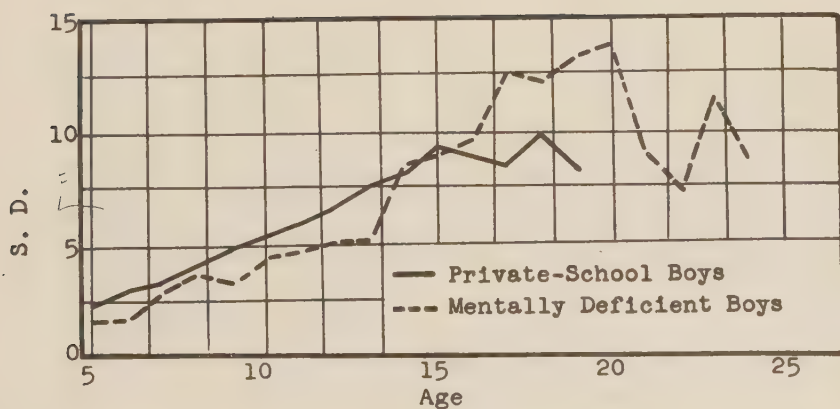


Figure 33.- The variability of weight for private-school and mentally deficient boys.

Private-school boys appear to be slightly more variable in weight at the early ages than mentally deficient subjects. If the variability were expressed in relation to the size of the mean¹ the differences would be insignificant and the position might even be reversed. After age fifteen the mentally deficient group is consistently more variable than private-school boys. An important point concerning the variability in weight is the general trend of the curves. The greatest variability in weight for private-school boys occurs at eighteen after which there is a decline. Mentally deficient boys continue to become more heterogeneous in weight until age twenty. An increase in variability during the earlier years and a decrease after some of the subjects have reached maturity is equally as true of height and weight as has already been observed for measures of carpal development.

Standard deviations for chest girth and hip width are presented in Figures 34 and 35, respectively. There is little difference in the variability of the two groups of boys in chest girth until late adolescence when mentally deficient boys are much more variable than private-school males. The difference in the time at which the two groups reach their greatest variability is one year for chest girth and three years for hip width. The increase in the variability of hip width is only about eight millimeters for private-school boys, while mentally deficient subjects have a range in variability of thirty points, which is about four times as great. The same general trend in variability is shown in Figures 34 and 35 as has already been described for other physical traits. Mentally deficient males are more variable than superior boys and continue to increase in variability over a greater number of years. The latter finding is in agreement with the results which show that mental defectives have a longer than average period of growth.

Standard deviations for head length and head height are given in Figures 36 and 37, respectively. The standard deviations for head measurements are quite irregular. If the curves were smoothed there would be little change in the variability of head size. The variability of head measurements with large samples reveals a relatively even standard deviation. The range in the variability of head height for private-school boys is slightly more than two millimeters, while the range for the subnormal group is about five millimeters. Both groups are so near maturity in head size that there is little change in the variability. These results show that the mentally deficient group is more variable in head size than private-school boys.

The data which have served as a basis for the anthropometric analysis seem to point rather consistently to the following growth conditions: Mentally deficient boys are below private-school boys in all measurements of body size. The levels attained at maturity show significant inferiority on the part of the subnormal group. Mentally deficient males grow at a relatively slow rate. The growth period appears to be longer for mental defectives than for the average individual. This finding is contrary to the results reported in other studies. Mentally deficient boys tend to be more variable than private-school males, and reach their greatest heterogeneity at an older age. The results indicate rather conclusively a superiority in physique on the part of private-school boys who are also superior in mental ability.

¹ The coefficient of variation has not been used because mentally deficient subjects are usually more variable in absolute amount without making a correction for the smaller means.

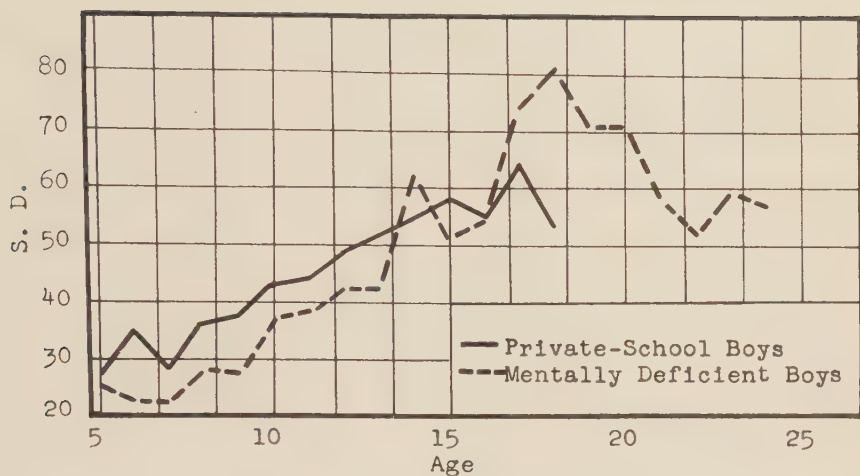


Figure 34.- The variability of chest girth for private-school and mentally deficient boys.

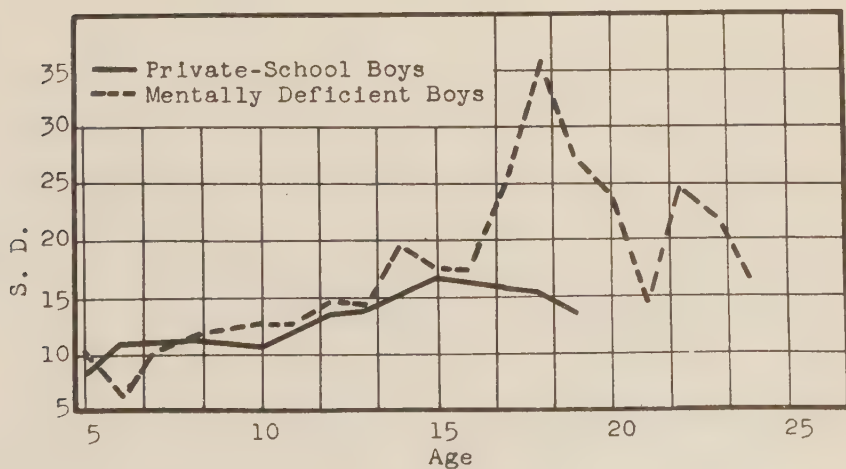


Figure 35.- The variability of hip width for private-school and mentally deficient boys.

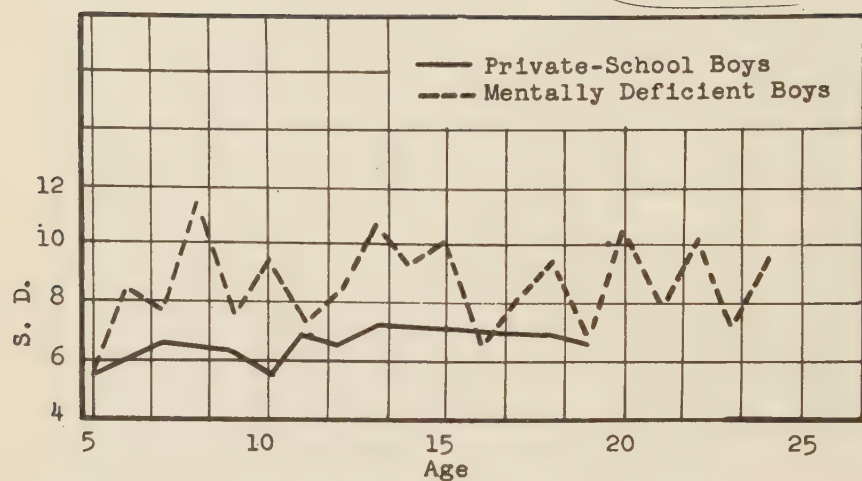


Figure 36.- The variability of head length for private-school and mentally deficient boys.

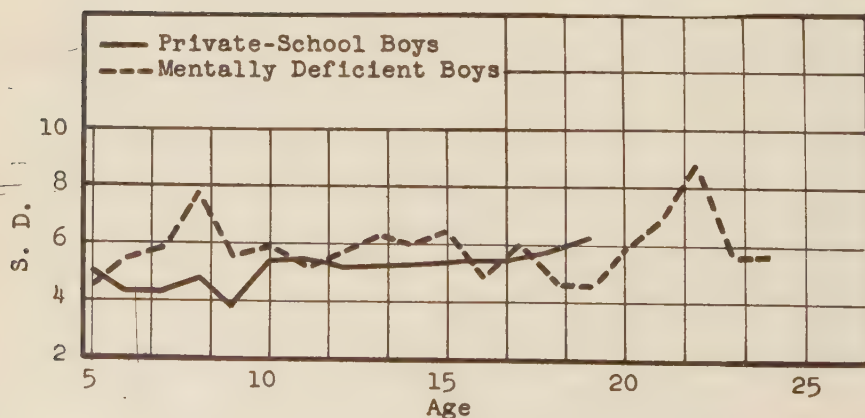


Figure 37.- The variability of head height for private-school and mentally deficient boys.

CHAPTER IV

THE RELATION OF GROWTH TO THE DEGREE OF MENTAL DEFECT

The evidence, which has already been presented, shows definitely that mentally deficient boys are below average in physical size. These smaller physiques have a longer period of growth than was found for private-school boys. It appears that there is a relationship between physical size and the level of mental ability. If this relationship is of sufficient magnitude, there should be significant differences in the size and development of low-grade and high-grade mentally deficient persons. This chapter will be devoted to an analysis of differences in physical growth which are associated with the level of mental ability.

Each age group was divided into classes A, B, and C in accordance with the method described in Chapter I. Means were calculated for each of the physical variables studied. It was found that the number in each class was too small to give consistent averages from age to age. It seemed, however, that there was a slight tendency for morons to exceed idiots in physical size. It was apparent that the data would have to be grouped in some manner in order to secure samples of sufficient size.

Preliminary calculations were made for idiots, imbeciles, and morons by combining all age groups into one sample. Small differences in physique were discovered but the average age of the three groups complicated the interpretation. Idiots were on the average one year older than imbeciles and two years older than morons. A possible explanation for this condition can be offered. Parents are willing to place a child who has been adjudged a moron in the state school with the hope that an adjustment to society will be made possible. The idiot, on the other hand, who is more infantile and helpless, is likely to be kept in the home for a greater number of years. The moron is the type of inmate who leaves the state institution either by escape or parole. There is little chance for an idiot to leave the institution except by death. The age distribution may have had a slight influence on the general results previously reported. A larger number of idiots at the earlier ages and a greater number of morons in the later years would serve to make the curves somewhat more paralleled for normal and defective boys, if the degree of deviation is related to the degree of the mental defect. But an equating of the groups in chronological age would certainly not erase the differences between normal and mentally deficient boys.

The age differences between the three classes of mentally deficient males can be removed by selecting subjects in such a manner that the average age of each group is the same. It was decided to use two points, eleven and sixteen, in the entire age range for purposes of comparison. The sample at age eleven was increased by adding an equal number of ten- and twelve-year-old subjects, respectively. Thus, the samples considered as eleven-years-old, range in age from 9-7 to 12-6 with an average of eleven. The sixteen-year-old groups were made up in a similar manner, by using an equal number of subjects at fifteen and seventeen, respectively, in order to make an average of sixteen. It is possible to compare the means for each class when the ages have been made comparable in this way. The reader should keep in mind that eleven and sixteen are in reality averages and not absolute ages.

Bone Growth

The bone age for the three classes is presented in Table VI. These data suggest a difference in favor of the higher grade mental defectives. Morons are superior to idiots in seven of the eight comparisons. The total ossification, the ossification ratio, and skeletal-months ratings are higher for imbeciles than for morons at age sixteen. Imbeciles and idiots are the same

in skeletal-months ratings at age eleven. A comparison of the subjects at three mental levels among mentally deficient subjects causes the same difficulty which frequently arises in an analysis of dull, normal, and bright children. An IQ basis for division is arbitrary and borderline subjects may very easily be misplaced. There can be no doubt that idiots and morons are clearly different in mental abilities. It seems justifiable, therefore, in making an analysis of differences among deficient subjects to use the two extremes, idiots and morons. It is apparent that the use of the two extreme classes will exaggerate relationships between mental and physical development, but this fact does not render the method invalid.

Averages in Table VI reveal that morons exceed idiots in the four carpal variables. The significance of these differences can be better understood when expressed in relation to their probable errors. The differences between the means for idiots and morons with the probable error of the difference are given in Table VII. Morons have a significantly greater bone development and a larger hand as shown by the total ossification and the carpal quadrilateral, respectively. The ossification ratio at age eleven is in favor of morons but the difference is less than twice its probable error. The chances are about one in five that this difference would be as small as zero or larger than ten. There is no difference in the ossification ratio at age sixteen. The ossification ratio is intended to correct for differences in sheer size but it is not as effective in its evaluations at the older ages on account of the complicated development. Skeletal-months ratings are in favor of morons at eleven, but like the ossification ratio are less than twice the probable error. The chances are, however, less than 1 in 20 at age sixteen that the difference between the two groups in skeletal-months evaluations would be as low as zero. These data indicate a real difference in skeletal size but a smaller difference in the stage of maturity. These two points will be further evaluated by reference to anthropometric measurements and secondary sex characteristics.

TABLE VI

SKELETAL AVERAGES FOR THREE CLASSES OF MENTALLY DEFICIENT
BOYS AT AGES ELEVEN AND SIXTEEN

Age and Class	No.	Variable			
		Total Ossification	Quadrilateral	Ossification Ratio	Skeletal-Months Ratings
Age 11					
Class A	24	137 $\pm$ 5.70	197 $\pm$ 3.37	68 $\pm$ 2.30	117 $\pm$ 3.04
Class B	55	142 $\pm$ 3.57	204 $\pm$ 2.74	69 $\pm$ 1.36	117 $\pm$ 1.56
Class C	67	162 $\pm$ 3.54	218 $\pm$ 2.28	73 $\pm$ 1.07	123 $\pm$ 1.53
Age 16					
Class A	49	272 $\pm$ 6.37	267 $\pm$ 4.33	102 $\pm$ 1.18	173 $\pm$ 2.01
Class B	56	308 $\pm$ 4.91	293 $\pm$ 4.48	106 $\pm$.90	186 $\pm$ 1.64
Class C	55	306 $\pm$ 4.73	299 $\pm$ 3.79	102 $\pm$.84	180 $\pm$ 1.67

TABLE VII

THE DIFFERENCES BETWEEN THE MEANS FOR MORONS AND IDIOTS
IN SKELETAL DEVELOPMENT AT AGES ELEVEN AND SIXTEEN

Age	Total Ossification	Quadrilateral	Ossification Ratio	Skeletal-Months Ratings
11	-25 $\pm$ 6.71	-21 $\pm$ 4.07	-5 $\pm$ 2.54	-6 $\pm$ 3.40
16	-34 $\pm$ 7.93	-32 $\pm$ 5.75	0 $\pm$ 1.45	-7 $\pm$ 2.61

TABLE VIII

ANTHROPOMETRIC MEANS FOR THREE CLASSES OF MENTALLY
DEFICIENT BOYS AT AGES ELEVEN AND SIXTEEN

Variable	Age 11			Age 16		
	A	B	C	A	B	C
Standing Height	1322 ± 12.19	1299 ± 7.42	1355 ± 5.98	1503 ± 12.84	1596 ± 9.50	1603 ± 7.66
Sitting Height	676 ± 4.78	691 ± 3.84	715 ± 2.65	783 ± 6.49	829 ± 5.91	830 ± 4.20
Arm Span	1297 ± 13.25	1277 ± 8.77	1344 ± 7.14	1509 ± 13.17	1596 ± 9.93	1619 ± 9.63
Weight	26.4 ± .69	27.6 ± .45	28.7 ± .38	41.4 ± .97	49.4 ± 1.04	48.0 ± .78
Chest Girth	633 ± 6.33	628 ± 4.18	635 ± 3.25	719 ± 6.50	758 ± 6.11	760 ± 4.20
Chest Depth	147 ± 1.94	144 ± 1.19	142 ± 1.01	171 ± 1.81	174 ± 1.72	170 ± 1.16
Chest Width	201 ± 1.91	199 ± 1.25	199 ± .98	224 ± 1.90	236 ± 1.80	234 ± 1.57
Hip Width	206 ± 2.08	206 ± 1.26	222 ± 1.13	236 ± 2.01	253 ± .89	252 ± 1.56
Head Length	175 ± 1.10	175 ± .79	179 ± .68	182 ± 1.12	183 ± .60	183 ± .68
Head Width	137 ± .94	141 ± .52	141 ± .37	143 ± .76	145 ± .67	145 ± .60
Head Height	116 ± .77	118 ± .44	118 ± .44	121 ± .64	118 ± .39	120 ± .40
Number of Subjects	24	55	67	49	56	55

Anthropometric Growth

Since the size of the carpal bones of idiots was found to be less than for morons, it is to be expected that idiots will be smaller in the anthropometric measurements. The average anthropometric measurements for idiots, imbeciles, and morons are given in Table VIII. These results show a general trend in favor of morons except for head and chest measurements. The physical inferiority of idiots may be seen more clearly when the difference between the means are observed. Mean anthropometric differences between morons and idiots with the probable error of each difference are presented in Table IX. The deviations are smaller at eleven than at sixteen. It has been shown previously that mentally deficient males become more unlike private-school and Laboratory School boys until in the later teens. It appears that a similar difference in growth rate may exist between idiots and morons.

Sitting height and hip width are significantly different at both ages,

TABLE IX

DIFFERENCES BETWEEN THE MEAN ANTHROPOMETRIC MEASUREMENTS OF
MORONS AND IDIOTS AT AGES ELEVEN AND SIXTEEN

Variable	Age	
	11	16
Standing Height	- 33 ± 13.58	- 100 ± 14.95
Sitting Height	- 39 ± 5.47	- 47 ± 7.73
Arm Span	- 47 ± 15.05	- 110 ± 16.32
Weight	- 2.3 ± .79	- 6.6 ± 1.25
Chest Girth	- 2 ± 7.12	- 41 ± 7.74
Chest Depth	+ 5 ± 2.19	+ 1 ± 2.15
Chest Width	+ 2 ± 2.15	- 10 ± 2.47
Hip Width	- 16 ± 2.37	- 16 ± 2.54
Head Length	- 4 ± 1.29	- 1 ± 1.31
Head Width	- 4 ± 1.01	- 2 ± .97
Head Height	- 2 ± .89	+ 1 ± .76

more than six times the probable error. Idiots have slightly deeper chests than morons at both eleven and sixteen years of age. Chest width is slightly in favor of idiots at eleven but significantly greater for morons at age sixteen. Idiots appear to be more round chested than morons. It may be that morons are more responsive to the opportunities provided for exercise and thereby increase their chest capacity at the older ages. Morons, at age sixteen, are significantly superior to idiots in standing height, sitting height, arm span, weight, chest girth, chest width, and hip width.

Average head dimensions are very similar for the two groups. Five of the six comparisons of head size are, however, in favor of morons. Head width is significantly different at age eleven, and the chances are less than one in twenty that the difference in head length would be as low as zero. The greater similarity in head size at sixteen suggests that morons and idiots may have different growth rates. Previous data have been presented to show that maturity is not attained in most of the anthropometric traits until about twenty years' of age, which is four years later than the age under consideration. Head height has approached its maximum more closely at sixteen than has any of the other anthropometric variables. If sufficient subjects were available so that comparative growth curves could be drawn, the questions which arise relative to the rate and duration of growth among the three classes of mental defectives might be solved. Repeated measurements of the same subjects over a period of years would give the most satisfactory data for studying the differences in growth rate among the mentally deficient group.

The evidence just presented shows that twenty-four of the thirty measurements compared favor morons, while eighteen of the differences were between three and seven times their probable errors. These results strongly suggest that the degree of physical deviation is related to the degree of mental defect. Mental deficiency does not seem to be an isolated misfortune which centers in the brain of the persons afflicted. Factors which operate to produce a mental debility, also seem to operate to produce a general physical inferiority. Myerson¹ has said, "It is notorious that the lower the mental level the greater the degree of defect, though there is by no means an exact parallelism."

¹ Myerson, *op. cit.*, p. 83.

The Onset of Pubescence

Puberty is a phenomenon which has aroused much interest in the field of child development. Changes which accompany pubescence have been well described in the literature of adolescent psychology. It is the concern of the writer to point out some differences which exist without going into the controversial issues connected with a study of pubescence.

Puberty is a point in the development of an individual which is usually inferred from secondary sex characteristics. Data which must be obtained by a single inspection are extremely inadequate. The best that can be done in the present study is to give the results obtained from the appearance of secondary sex characteristics. Evidence that puberty will soon be reached is based upon the presence of pubic hair. Subjects have been considered pre-pubescent until there was a definite trace of axillary hair or a slight beard. Boys who had both pubic and axillary hair were considered pubescent. A subject who had a slight beard in addition to pubic and axillary hair was termed post-pubescent.

The percentage of the subjects pre-pubescent, pubescent, and post-pubescent was determined for each age group. These data have been given in tabular form in the appendix. The comparisons are more evident when the results are presented graphically. None of the subjects used in this study had reached pubescence prior to age twelve, although one moron had a slight trace of pubic hair at age ten. The relative percentage pre-pubescent, pubescent, and post-pubescent is shown in Figures 38 and 39. It is interesting to note in Figure 38 that less than 80 per cent of the twenty-year-old mentally deficient males have the secondary sex characteristics of normal post-pubescent boys. More than 50 per cent of the sixteen-year-old boys are pre-pubescent. Seventy-five per cent of the seventeen-year-old boys are either pubescent or post-pubescent, with 47 per cent of the subjects falling in the former group. It appears that the average mentally deficient boy, when judged by his secondary sex characteristics, reaches puberty sometime between his sixteenth and seventeenth birthdays. The delayed pubescence compares favorably with the general retardation in his physical growth. Crampton has shown that the average boy reaches puberty between thirteen and a half and fourteen years of age.¹ Gifted boys have all reached puberty by the age of fourteen and 25 per cent are pubescent at age twelve.² Mentally deficient boys appear to be from two and a half to three years late in acquiring the secondary sex characteristics which accompany puberty.

This comparison between idiots and morons with respect to pubescence throws some light on the major problem of this chapter. The percentage pre-pubescent and post-pubescent for morons and idiots has been given in Figure 39. Pubescence begins earlier and progresses more rapidly among the moron class. There is no indication of the onset of pubescence among idiots until after age thirteen. All of the morons appear to be pubescent at the age of twenty. Three idiots who were more than twenty-one years of age did not possess the secondary sex characteristics of pubescent boys. Of course, there is no certainty that idiots ever become pubescent in the true sense of the word. Most of them are considered to be sterile. Pubescent has been used throughout this discussion to mean the presence of secondary sex characteristics. These signs are sufficient for comparative purposes.

These data indicate that mentally deficient boys are delayed in their pubertal development. They appear to be retarded to a greater degree in their physiological maturation than in either their bone growth or the development of their body proportions. The amount of delay in puberty is

¹ C. W. Crampton, "Anatomical or Physiological Age Versus Chronological Age," *Pedagogical Seminary*, XV (June, 1908), 230-37.

² Terman, *op. cit.*, p. 207.

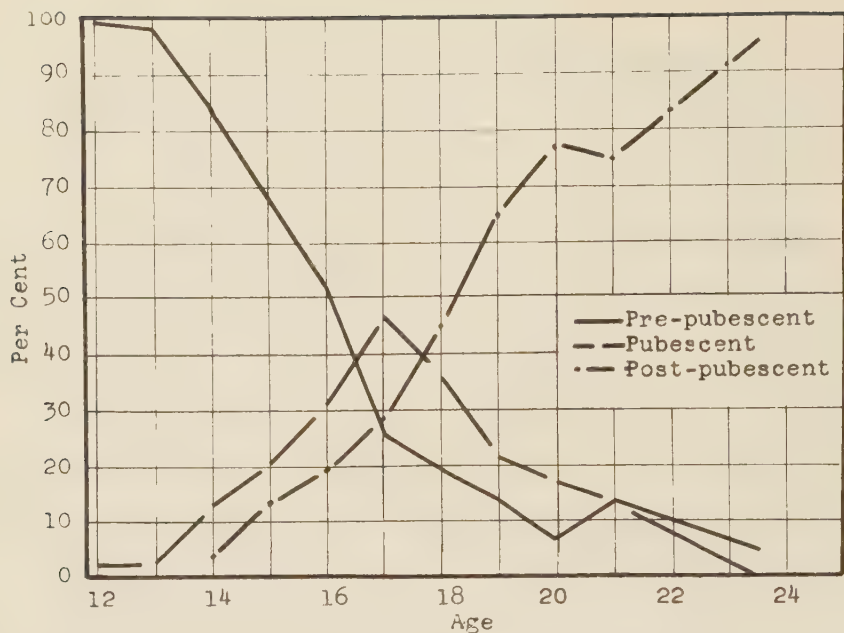


Figure 38.- The pubescent development in amented boys.

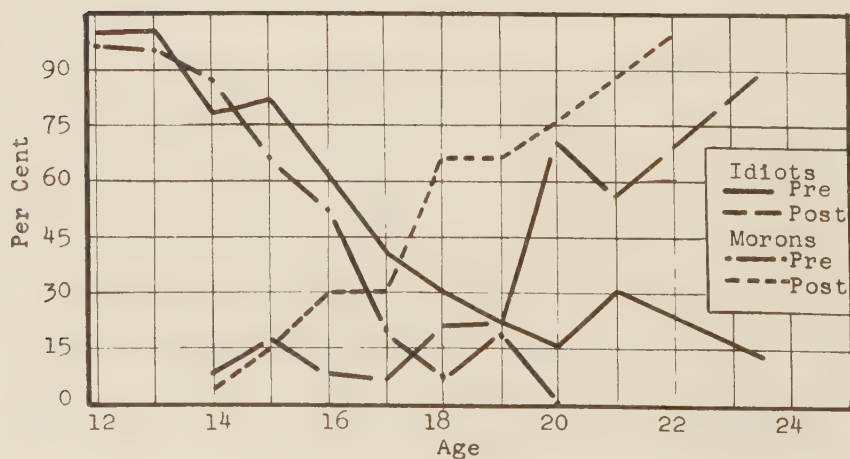


Figure 39.- Comparison of idiots and morons in pubescent development.

related to the degree of mental defect. The moron has an earlier pubescence than the idiot, while the normal boy reaches puberty earlier than the average moron.

The data of this chapter constitute additional evidence to support the hypothesis that mental ability is associated with physical development. The lower the level of mental ability the more likely is one to find deviations in size and physiological maturity. Mentally deficient individuals seem to have a different type of organism throughout. These data support Myerson when he says,

Many feeble-minded show their inferiority in as gross physical disorder as mental disorder, and no medical man can view them without the distinct impression that the "feeble-mindedness" is a symptom in the course of something which has blighted or injured the whole organism.¹

Whether these phenomena of physical growth are likewise true of the mental growth of mental defectives remains to be determined. Most writers on the subject have contended that mentally deficient persons attain their maturity at an early age. The evidence of this study flatly contradicts such a view.

¹ Myerson, op. cit., p. 83.

CHAPTER V

ENVIRONMENTAL AND HEREDITARY FACTORS

There are certain environmental and hereditary circumstances which are associated with the physical growth and development of the child. It is impossible to determine from the data at hand what factors have operated to cause any given individual to be classified at the lower end of the intellectual scale. The causation of mental deficiency is not the major concern of this study, but the investigation would be incomplete without a consideration of circumstances which may have influenced the development of the subjects. It is the purpose of this chapter to indicate some of the conditions, recorded in case histories, which may have operated to retard the growth of mental defectives.

This analysis of factors affecting growth has been made solely on the basis of records which are on file in the state institutions. The reader must keep in mind the inadequacy of these data. The handicaps in obtaining evidence are in no sense the fault of the institutional staff. It is extremely difficult to procure an authentic history of a mentally deficient child, when the informant is a mentally deficient or an illiterate parent. The early history was not available for a number of the subjects. A majority of the subjects have incomplete records. Findings from such data must be considered as suggestive rather than conclusive. Attention will be given to the family stock, the occupational and social status of the parents, birth conditions including data for siblings and birth trauma, walking, talking, teething, illnesses, and certain congenital types of mental deficiency.

The Family Stock

"The Kallikak's", "the Jukes", "the Nams", and "the Hill Folk", are too well known to need amplification. Any informed person is aware that these fictitious family names have been employed to show that mental deficiency is a heritable condition. Biologically minded individuals have no doubt that the offspring of two mentally deficient parents are likely to fall on the lower ranges of the intellectual scale. There is, however, serious question whether the deficiency in mental ability is a Mendelian trait. Myerson indicates¹ very clearly the dangers in relying too much upon the histories of the fictitious families mentioned previously. If the clinician who has all of the modern devices for diagnosing mental status is often compelled to revise his first impressions, it seems rather credulous to accept the verdict of field workers when they diagnose the mental condition of individuals who have been dead for more than a century. Dayton contends² that the inheritance of mental deficiency would be relatively simple if it appeared in a Mendelian ratio, "but, the social influence on mental ability makes the inheritance of feeble-mindedness so complex that it is beyond solution."

Since the type of family stock and not the inheritance of deficiency is the major concern of the writer, the available data will be presented. At least a partial report was available for 695 fathers, 686 mothers, and 722 families. In some instances data were available only for the father and in others only for the mother. There is a discrepancy in the use of 722 families as the base for calculating the percentages to be given, but a trend can be shown.

¹ Abraham Myerson, *op. cit.*, p. 77 ff.

² Neil A. Dayton, "Difficulties in Determining Inheritance of Mental Defect," *New England Journal of Medicine*, CCIII (July, 10, 1930), 73-76.

The records show that in 77, or 10.7 per cent, of the families, parents only, one or both, were deficient in mental ability; in 58, or 8.0 per cent, at least one parent and one or more siblings; in 98, or 13.6 per cent, other siblings only; and 30 or 4.2 per cent, other relatives, such as uncles or grandparents, were mental defectives. A recombination of these data shows that in 18.7 per cent of the families one or both of the parents were deficient in mentality; 21.6 per cent of the families had more than one sibling who was classified as feeble-minded; while 36.4 per cent of all families had one or more mentally deficient members, either parents or siblings.

The histories reveal that in approximately 1 per cent (0.97) of the homes one parent was insane. Four per cent of the families had other relatives who were demented, while five families reported bad heredity without indicating the type of deviation.

Coupled with these instances of known defects in the hereditary stock are certain other circumstances which probably impair the physical well-being of the offspring. Ninety-nine, or 14.2 per cent, of the 695 fathers reporting were alcoholic. Fifty-two, or 7.6 per cent, of 686 mothers were alcoholic. Seventeen fathers and four mothers had criminal records. Fifteen fathers and twelve mothers were reputed to be mean and irritable. Thirteen fathers, 1.9 per cent, and fifteen mothers, 2.2 per cent, were known to be loustic. Thirteen pairs of parents were known to be related, while three subjects were the offspring of an incestuous relationship. Nineteen parents were sex perverts. Twenty-five homes were broken by divorce or dissolution. Nineteen homes were characterized merely by the expression, "bad home condition." Eighteen of the subjects were abandoned in infancy.

6

When the foregoing circumstances are coupled with additional cases of prostitution, illegitimacy, poverty, and social degeneracy, it is easily understood how the family stock may influence growth in a very unfavorable manner. It is indeed surprising that the offspring of certain parents survive long enough to reach the state institutions. The high mortality rate will be discussed in a later section. It is sufficient at this point to indicate that a large proportion of mentally deficient children grow up under circumstances which appear to be adverse until they have the care and protection of state institutions.

Although the causes of mental deficiency are difficult to isolate, the prevalence of unfavorable circumstances in the homes of the patients lends weight to the notion that the level of the intelligence may be, at least in part, the result of the family stock. One must not hasten to conclusions without viewing the other side of the situation. The fact that many of the aments are sterile¹ and that mental deficiency appears in families where no trace of previous amentia can be found, raises the question as to the nature of other conditions which may bring about mental deviations.

Parents are prone to look for an environmental condition which may have been responsible for low mental ability. A record was made of the different types of reasons which parents offered to explain the defect. The explanations given are as follows:

Head injury, severe illness, suicide of the grandfather during the mother's pregnancy, scalding, frightened by a false-face, just happened, fell out of bed, tuberculosis in the neck, drugs given for pneumonia, abscess on the ear, bumped his head, illness of the mother during pregnancy, association with other children, neglect, mother frightened during pregnancy, poison in his milk, fall during the first day, gruesome stories told to the mother during pregnancy, birth injury, kicked by a horse, scared by a snake, shock, hard work

¹Myerson, *op. cit.*, p. 82.

by the mother during pregnancy, mother teased by a monkey.

Some of the reasons suggested are quite plausible. It is known that severe illness and birth injury have produced cases of mental deficiency. Medical science has discarded any notion that such environmental factors as "snakes", "monkeys", or "false-faces" could produce amentia. Degrading associates and neglect of the child are conditions which help to make a bad heredity worse or a good heredity bad. This issue can be further analyzed by presenting additional data.

Occupational and Social Status

Parents who are low in mental capacity would be expected to find employment at the lower social levels. Occupational status is connected with the economic return. In general, the lower the occupational status the smaller the income. A small income can provide only meagerly for the needs of the family. It is known¹ that the lower the occupational status the larger the family. More children and smaller incomes mean fewer advantages and intellectual opportunities.

Studies have shown² that the intellectual status is related to the occupational and social level of the parents. The results of the testing in the army revealed³ a relationship between intelligence and occupational level. Some further indication concerning the economic level of the parents of mentally deficient children may be gathered from their occupational status. The occupational status of parents of the subjects for each class and the total group is presented in Tables X and XI. The occupational classification is the same as was used in the study of gifted children.⁴ It is striking to note the slightly larger percentage of fathers of idiots in the professional and skilled occupations than was found for imbeciles and morons. It is at least interesting, if not significant, to note that a larger proportion of the mothers of idiots were housewives. The interpretation of these two facts is not very clear. It may be that factors other than heredity are producing a larger number of idiots than imbeciles and morons. It is possible that the defective germ plasm from apparently normal parents has a tendency to deviate more from the normal than defective germ plasm among the lower mental levels. It is known that professional and skilled persons marry late and have children at an older age than the average parents. Dayton found⁵ that abnormal labor is more frequently associated with the first born. It is conceivable that a large proportion of idiots may be the result of birth injury. The available data are neither adequate nor sufficiently reliable to answer this question.

Fathers of mentally deficient children are predominantly in the lower occupational groups. Skilled laborers contribute more to the mentally

¹ Recent Social Trends in the United States, Report of the President's Research Committee on Social Trends, Vol. I., pp. 85-86. New York: McGraw-Hill Book Co., Inc., 1933.

² S. L. Pressey, and Ruth Ralston, "The Relation of the General Intelligence of School Children to the Occupation of their Fathers," Journal of Applied Psychology, III (December, 1919), 366.

James W. Bridges, and Lillian E. Coler, "Relation of Intelligence to Social Status," Psychological Review, XXIV (January, 1917), 1-31.

Rudolph Pintner, Intelligence Testing, p. 513. New York: Henry Holt and Co., 1931.

³ R. M. Yerkes (Editor), "Psychological Examining in the U. S. Army," Memoirs National Academy of Science, Vol. XV, Part III, Chapter XV, Washington, D. C. 1921.

⁴ Louis M. Terman and Others, Genetic Studies of Genius, Vol. I, p. 63. Stanford University, California: Stanford University Press, 1925.

⁵ Neil A. Dayton, "Abnormal Labor as an Etiological Factor in Mental Deficiency and Other Associated Conditions," New England Journal of Medicine, CCIII (August 28, 1930), 398-413.

TABLE X

THE OCCUPATIONAL STATUS OF THE FATHERS
OF MENTALLY DEFICIENT BOYS

Occupation	Classes							
	A		B		C		All	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Professional	10	6.1	6	2.9	1	0.5	17	2.9
Semi-Professional and Business	13	7.9	16	7.8	9	4.3	38	6.6
Skilled Labor	82	50.0	95	46.3	74	35.2	251	43.4
Semi-Skilled to Slightly Skilled	21	12.8	25	12.2	18	8.6	64	11.1
Common Labor	38	23.2	63	30.7	108	51.4	209	36.1
Total	164	100.0	205	99.9	210	100.0	579	100.1

TABLE XI

THE OCCUPATIONAL STATUS OF THE MOTHERS
OF MENTALLY DEFICIENT BOYS

Occupation	Classes							
	A		B		C		All	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Professional	2	1.6	4	3.0	1	0.8	7	1.9
Semi-Professional and Business	3	2.4	2	1.5	0	0.0	5	1.3
Skilled Labor	3	2.4	1	0.7	4	3.4	8	2.1
Semi-Skilled to Slightly Skilled	4	3.2	16	11.9	14	11.9	34	9.0
Common Labor	1	0.8	0	0.0	1	0.8	2	0.5
Housewife	113	89.7	111	82.8	98	83.1	322	85.2
Total	126	100.1	134	99.9	118	100.0	378	100.0

deficient population than their relative place in Illinois vocations.¹ The distribution of vocations in Illinois was given as follows: "professional 3 per cent, semi-professional and business 35 per cent, skilled 39 per cent, semi-skilled to slightly skilled 15 per cent, and common labor 8 per cent." The occupational distribution for fathers of gifted children was reported as follows² for the five groups, respectively: "31.4; 50.0; 11.8; 6.6; and

¹ Twenty-Seventh Yearbook, National Society for the Study of Education, Nature and Nurture, Part I., p. 140. Bloomington, Illinois: Public School Publishing Co., 1928. Pp. ix + 465.

² Terman, *op. cit.*, p. 64.

0.1." The percentage of fathers of gifted children who are in the professions is nearly three times as large as for fathers of mentally deficient subjects. Interestingly enough the fathers of mental defectives are in the professional class slightly more often than the average for the state of Illinois. At the other extreme 36 per cent of the fathers of mental defectives are common laborers, while only 8 per cent of the fathers in Illinois are in the common labor class, and only one-tenth of one per cent of the fathers of gifted children were so rated. Fathers of gifted children are found most frequently in the upper occupational levels, while fathers of feeble-minded boys are at the lower end of the occupational scale. This condition is certainly a factor which contributes something to the growth of the child. Deprivation, want, and suffering are probably very common among families into which mental defectives are born. Gifted children come from homes which should be able to provide not only the necessities of life but also those luxuries and advantages which would tend to stimulate both physical and mental growth. The amount of influence of home conditions has been reported for foster children.¹ There is little doubt that the home condition has contributed to the sum total of the personality of mentally deficient subjects, but the exact amount can not be determined from data in the present study.

Years in the institution.— Mentally deficient boys who have served as the subjects for this study have been removed from parental and home influences. The mere fact that a portion of the feeble-minded population has been committed to public institutions means that their environmental surroundings have been seriously changed. There are individuals who deplore institutionalization. It is their contention that the growth of children is likely to be hampered by the confinement. Modern institutions are no longer cell-like arrangements which were too common in the days when little differentiation was made between dementia and amentia.

A few examples will be given to help the reader realize the educational background from which a portion of the mentally deficient subjects have been recruited. The following is a sample of a letter written to a state institution by a mother of one of the patients:

dear friend Just a few lines to find out how my little sun is
gitten along as I am so Wired about him as I cant hear from him his
name is (No. 239) I have not hered a word since he been gon will you
please rite me a few lines let me how he is surnty wold be glad

Another mother always wrote on the back of a communication which she had received from the institution. The following is typical of her style:

uell hou is (an older boy) by this time and is he well now and
is he Change any yet
how is little (No. 316) ageting along by this time and is he uell
uell I am Sorrow I have not uroght soon But have goin from home
yours truly

The educational effect of institutional life would certainly be an improvement for children who come from homes at the level illustrated by the foregoing correspondence. The second mother never signed her name. Her letters came rather frequently but were invariably identical in content. Reports made to the home seemed to have little effect on the future inquiry. These two homes may be considered somewhat typical of the parents at the lower occupational level, the common laborers. These two homes show no record of crime or sex delinquency in their history, but they continue to add more than their share of low-grade offspring to the population.

Another type of home can be illustrated by history No. 415. Father: la-

¹ Twenty-Seventh Yearbook, op. cit.

borer, mean, irritable, alcoholic, was murdered by his wife at the age of thirty-seven. Mother: was a housewife, mean, irritable, insane, criminal, and sex pervert. Siblings: five living and one dead, all mentally deficient, three in the state institution, all have been in an orphanage. The family reveals: mental deficiency, insanity (three uncles), epilepsy, syphilis, and sex perversion. The history is bad on both the paternal and the maternal side of the family.

It is difficult indeed to see how the life of a child could be influenced unfavorably by transferring him from such environment to a state institution. Still another type of case will be cited. The commitment papers of case No. 235 carried the following memorandum:

All children of the family are feeble-minded. No. 235 was the child of the most ignorant parents, in a most filthy home, he had a nest of leaves - not a bed - just like an animal - no schooling and never went anywhere until large enough to stroll to town and was then wild and afraid of the cars.

These four types of cases have been cited to support the contention that for many, if not most, of the aments, it is difficult to understand how institutionalization could serve as a detriment to their growth process.

A tabulation of the number of years spent in the institutions revealed that idiots have had an average residence of $6.9 \pm .21$, imbeciles $5.1 \pm .16$, and morons $4.1 \pm .15$, with an average for all subjects of $5.1 \pm .10$. The average C. A. of the three groups was $16 \pm .21$, $15 \pm .19$, and $14 \pm .17$, respectively. These data show that the average subject studied has spent ten years of his life outside the institution, which is nearly two-thirds of his age.

One might continue at length to pile up case histories which give such facts as: "father deserted the family", "mother deserted the family", "child abandoned", "sex delinquent parents", "criminal parents", "gypsy-like parents", "father-daughter incest", "damage to the skull by a midwife", "born at a county infirmary", "child blinded by his grandmother", "mother and grandmother illegitimate", and the like. Extremes have been mentioned but the actual conditions of the homes can hardly be described by a single phrase. The nature of some of the handicaps under which children are compelled to live have been suggested.

The home influence may have operated to help or hinder the growth process. The subjects in the present study have spent on the average one-third of their time in an institution. Table XLVI in the appendix gives the distribution of the subjects according to the number of years which they have been in the institution. Class C has 55 of 306 cases, 18 per cent, who have had a residence of less than one year. Forty-four per cent of the morons have been in the institution less than three years. The excessively high death rate, which will be discussed in connection with illnesses, serves to cut down the average residence. At Fort Wayne, a definite attempt was being made to move the uneducable to the farm colony and make room for additional trainable morons. This factor has weighted the distribution, for Class C, somewhat in the earlier years. The shorter residence of morons is due in part to escapes and paroles. Idiots come late but stay longer because they are too dull to escape and too feeble-minded to be paroled. Whether in the institution or at home the idiot can participate in few recreational or social activities. His life is much more sedentary, therefore, the lack of exercise probably has some influence on his growth rate.

The evidence seems to indicate that the social status of the home and the economic returns secured by the father are factors which are likely to have an influence upon the development of the child. There appears to be no reason for believing that institutional life is any more detrimental to the

growth process than the home environments from which the subjects came. It is perfectly clear that medical care and sanitary conditions of the institutions are far superior to those available in the average home from which mentally deficient children are enrolled.

Birth Conditions

Birth conditions have been interpreted broadly to include the age of parents, the number of siblings, the type of delivery, and birth injury. The data are unsatisfactory on these points, but calculations have been made, on the basis of the reports, with the hope that some trends might be suggested.

Family size.- The mean number of siblings reported was determined for each class. The distribution of the siblings with the percentage of subjects falling in each interval is shown in Table XII. Partial data concerning siblings were available for 624 subjects. The range in number of siblings is from none to fifteen. Twenty-five subjects had ten or more siblings, while six were reported as only children. The modal number of siblings is two, while the average is more than four. The differences between the means are insignificant for the three classes. The average number of children in the 624 families is 5.1. Therefore, the average family which supplies the mentally deficient population is composed of seven members.

Of course, a large number of these children have never had a normal family life. Records are available concerning the marital status of the parents of 515 subjects. Approximately 10 per cent (9.7) of the subjects were illegitimate. It is interesting to note that the frequency of illegitimacy is related inversely to the order of intelligence. The idiot class reported 6.4 per cent illegitimacy, the imbeciles 7.5 per cent, while 27 morons, or 14.4 per cent, were illegitimate. It has been shown previously that a smaller proportion of the mothers of morons were housewives. It appears that sex perverts and prostitutes contribute more to the moron class than to the other two groups. It may be that parents of illegitimate children are at a low intellectual level and their offspring fall still lower, although the law of regression is against it. It is possible that a number of women who are low in mental ability are seduced by men who are at a higher intellectual level. The reason is not clear, but the fact remains that illegitimate children are found most frequently in the moron group.

Green found¹ in his study of the birth rate of mentally deficient families that each feeble-minded mother produces an average of $6.4 \pm .17$ children. He concluded that since the birth rate was very high and the death rate no higher than normal, the number of offspring more than replaced the parental group. There are several reasons why Green's results do not apply to all parents of mentally deficient children. His study included only feeble-minded women who had been found to be fertile. The proportion of the mental defectives who are sterile would have to be considered in order to get a true picture. Some of the mothers who have mentally deficient children must be classed as intellectually normal. Thus Green's mean is neither the birth rate for mentally deficient women nor the birth rate for all mothers of mentally deficient children. Dayton found,² in a study of 10,455 subjects, that families into which a mentally deficient child is born have a tendency to be larger than families with retarded children. "Completed families with a child in the lower levels of intelligence are approximately twice as large as completed families with a child in the upper levels of intelligence." He also pointed out that the stock which is producing mental defectives is more than maintaining itself.

¹ Charles V. Green, "Birth and Death Rates of the Feeble-minded," Journal of Juvenile Research, XII (September - December, 1928), 244-48.

² Neil A. Dayton, "Order of Birth and Size of Family," American Journal of Psychiatry, VIII (May, 1929), 981 - 1006.

TABLE XII

THE NUMBER OF SIBLINGS REPORTED FOR MENTALLY DEFICIENT BOYS

Siblings	Class A		Class B		Class C		All Subjects	
	N	Per Cent	N	Per Cent	N	Per Cent	N	Per Cent
0	1	0.6	3	1.3	2	0.9	6	1.0
1	19	11.9	34	14.8	33	14.0	86	13.8
2	35	21.9	37	16.2	32	13.6	104	16.7
3	21	13.1	44	19.2	37	15.7	102	16.4
4	22	13.8	27	11.8	39	16.6	88	14.1
5	16	10.0	30	13.1	32	13.6	78	12.5
6	17	10.6	21	9.2	19	8.1	57	9.1
7	13	8.1	20	8.7	13	5.5	46	7.4
8	6	3.8	4	1.7	11	4.7	21	3.4
9	2	1.3	4	1.7	5	2.1	11	1.8
10	2	1.3	4	1.7	7	3.0	13	2.1
11	2	1.3	1	0.4	1	0.4	4	0.6
12	2	1.3	0	0.0	1	0.4	3	0.5
13	2	1.3	0	0.0	2	0.9	4	0.6
14	0	0.0	0	0.0	0	0.0	0	0.0
15	0	0.0	0	0.0	1	0.4	1	0.2
Number of families	160		229		235		624	
Number of siblings	672		886		998		2556	
Average per subject	4.20		3.87		4.25		4.10	
Total number of children	832		1115		1225		3180	
Mean per family	5.20		4.87		5.25		5.10	

Terman found¹ that in 92 completed families which produced superior children the average number of births, exclusive of miscarriages, was 3.35. Relatively few mothers of feeble-minded children had reached 45 years of age when the child was committed to the institution. Forty-five families were found which might be considered as complete. The average number of children for these mothers was 5.2 as compared with 5.1 for the entire group. It seems reasonable to accept the mean of the total group as the approximate size of the families in Illinois and Indiana which produce mentally deficient children.

The evidence is clear that normal, superior, and gifted children are in the better families economically and intellectually. Precocious children not only have greater resources back of them, but also may obtain a relatively larger proportion of the family budget due to the smaller family size. It is clear that the advantages for growth and development are all in favor of the children on the higher intellectual planes.

¹ Terman, *op. cit.*

Birth order.- Thurstone and Jenkins concluded¹ that intelligence increases with birth order at least as far as the eighth born. Dayton found² that birth order had very little significance among mentally deficient children.

The birth order was stated for 509 of the subjects used in this study. The average birth order for all subjects was $3.3 \pm .07$. The mean order for idiots was $3.6 \pm .15$, for imbeciles $3.2 \pm .10$, and for morons $3.1 \pm .10$. There is a trend which suggests a later birth order for idiots, but the difference is not three times the probable error. The distribution of the birth order with percentages at each interval is shown in Table XIII. Approximately one quarter of the subjects were first born. Since these children have on the average four siblings, it appears that the incidence of first borns among the defectives may have some significance.

Abnormal birth conditions.- There is little agreement among authorities as to the incidence of birth trauma, but the seriousness of such injury can easily be understood. A very important work has appeared which treats the psychological aspects of birth injury as related to mentally deficient individuals.³

The record of birth conditions was incomplete for a number of the subjects. A total of 553 records were partially complete in this respect. The differences between the three classes of subjects were insignificant. The conditions reported for the group as a whole are shown in Table XIV. Terman reported⁴ that 19 per cent of the gifted boys were delivered instrumentally. The percentage is more than twice as large as that reported for defective boys. On the other hand, prolonged labor was reported for more than 5 per cent of the births of mentally deficient boys, as against no cases among gifted boys. Medical care was certainly superior in the better homes. A larger number of instrumental deliveries and no cases of protracted labor reflects the modern trend in obstetrics. It is the opinion of obstetricians that there is more danger of brain injury by prolonged labor than by instrumental delivery. The fact that thirteen subjects showed deficient animation is an indication of a weak physical constitution.

It was thought that subjects whose etiology had been diagnosed as cerebral injury at birth or in early childhood might show a different development than subjects who from all appearances were congenitally feeble-minded. Twenty-five boys were found who had apparently suffered some severe brain lesion. These twenty-five individuals were paired with subjects of equal age and intellectual status who came from families in which other members were known to be deficient in mental ability. The congenital group was selected so that no subject had suffered any severe illness. If brain injury is local in effect, those individuals who become mentally deficient because of lesion should be more nearly normal in physical size than the congenital group.

The congenital group was composed of subjects who had slightly longer but flatter heads. Neither difference was significant. The injury group had wider hips and narrower chests, but both of these differences were insignificant. The differences in height and weight were 3 ± 1.73 and 1.4 ± 1.67 in favor of the injury group. Such small differences must be interpreted as insignificant. Skeletal-months ratings and ossification ratios were in favor of the injury group but the probable errors were nearly as

¹ L. L. Thurstone and Richard L. Jenkins, "Birth Order and Intelligence," Journal of Educational Psychology, XX (December, 1929), 641 - 51.

² Dayton, op cit.

³ Edgar A. Doll, Winthrop M. Phelps, and Ruth Taylor Melcher, Mental Deficiency Due to Birth Injury. New York: Macmillan Co., 1932. Pp. vii + 289.

⁴ Terman, op. cit., p. 181.

TABLE XIII

THE BIRTH ORDER REPORTED FOR MENTALLY DEFICIENT BOYS

Birth Order	Class A		Class B		Class C		All Subjects	
	N	Per Cent	N	Per Cent	N	Per Cent	N	Per Cent
1	35	25.5	43	22.2	45	25.4	123	24.2
2	27	19.7	43	22.2	43	24.3	113	22.2
3	19	13.9	37	19.1	30	16.9	86	16.9
4	16	11.7	32	16.5	20	11.3	68	13.4
5	12	8.8	14	7.2	19	10.7	45	8.8
6	6	4.4	9	4.6	7	4.0	22	4.3
7	11	8.0	8	4.1	7	4.0	26	5.1
8	5	3.6	5	2.6	2	1.1	12	2.4
9	3	2.2	2	1.0	2	1.1	7	1.4
10	2	1.5	1	0.5	1	0.6	4	0.8
11	1	0.7	0	0.0	1	0.6	2	0.4
12	1	0.7	0	0.0	0	0.0	1	0.2
Number of Subjects	138		194		177		509	
Average Order	3.58 $\pm$.15		3.18 $\pm$.10		3.06 $\pm$.10		3.25 $\pm$.07	
Standard Deviation	2.55 $\pm$.10		1.99 $\pm$.07		2.03 $\pm$.07		2.16 $\pm$.05	

TABLE XIV

ABNORMAL BIRTH CONDITIONS REPORTED FOR 553
MENTALLY DEFICIENT BOYS

Condition	Number	Per Cent
Difficult Labor	102	18.4
Instrumental	40	7.2
Prolonged Labor	28	5.1
Premature	20	3.6
Anesthetics Used	15	2.7
Deficient Animation .	13	2.4
Precipitated	3	0.5
Caesarian	1	0.2

large as the differences.

These results agree with the findings reported by Dayton for 20,473 retarded and mentally deficient children.¹ He found an insignificant relationship between abnormal labor and height, weight, physical defect, school accomplishment, and intelligence. The influences of abnormal labor were observed both in mental defectives and in retarded children.

These data indicate that amentia whether congenital or the result of brain lesion need not be considered separately in a study of the physical growth of the mentally deficient persons. Mental deficiency appears to be due to a type of defect which spreads over the entire organism. Myerson²

¹ Neil A. Dayton, "Abnormal Labor as an Etiological Factor in Mental Deficiency," *Proceedings of the American Association for the Study of Feeble-minded*, XXXV (May, 1930), 148 - 202.

² Myerson, *op. cit.*, p. 83.

contends that mental deficiency is a condition of the whole organism and not confined to the central nervous system.

Age of parents.— The age of parents at the birth of the child may be a factor which has some influence on growth. Children born to very young parents are likely to endure some economic hardships. When parenthood is delayed, the child may run a greater risk of birth injury, but the economic status of the home is likely to be more favorable.

Table XV gives the average age of parents at the birth of the child for mentally deficient boys. The only significant difference in the average age of parents for the three groups is the older age for both fathers and mothers of children in the idiot class. The reason for this condition is not very clear. It has been shown that a larger percentage of the parents of idiots were professional people but it does not seem likely that delayed parenthood among ten fathers would produce an average age difference of more than five years for the entire group. Seven fathers of idiots were more than fifty years of age when the children were born, but eleven fathers of imbeciles, and eleven fathers of morons were also past fifty when the subjects were born. The other age extreme is more significant. Only one father in Class A was twenty or younger, while four fathers in Class B, and eight in Class C were below the age of twenty-one when the children were born. It has been shown that mentally deficient males have a delayed pubescence. Therefore, it is possible that the lowest grade in society who produce offspring tend to have their children at an older age due to a retardation in physiological maturity.

TABLE XV

THE AVERAGE AGE OF PARENTS AT THE BIRTH OF THE CHILD

Class	Father			Mother		
	No.	Mean	Standard Deviation	No.	Mean	Standard Deviation
Idiot	145	39.11 ± .52	9.30 ± .37	148	29.16 ± .39	7.08 ± .28
Imbecile	184	33.41 ± .47	9.41 ± .33	185	27.50 ± .35	7.10 ± .25
Moron	145	34.00 ± .54	9.69 ± .38	158	26.48 ± .36	6.66 ± .25
All Classes	474	34.05 ± .29	9.48 ± .21	491	27.65 ± .21	7.02 ± .15

It is interesting to note the age of parents reported by Terman¹ for gifted children. The age of fathers was 33.6 and the age of mothers was 29.0 at the birth of the child. These means do not differ greatly from the average age of parents for all classes of mentally deficient boys. The similarity in the average age of parents may have been produced by entirely different factors. The economic and socially better classes are known to delay the age of parenthood voluntarily, while the lowest grades of humanity may be forced to delay parenthood because of physiological immaturity. The data are not available to answer these questions. If the answer were known, it would contribute very little to the present study. The age of parents does not seem to differ significantly, however, there is a tendency for parents of idiots to be older than parents of subjects in other classes. There is probably more birth injury in the idiot class. Twelve of the twenty-five subjects used in an analysis of birth injury were in the idiot group. But the injured group grew in the same manner as other defectives, with the exception of a greater incidence of paralysis. The older age of parents should not work a disadvantage on the child. In fact, it has been argued that the economic status of the family should make it possible to care for

¹ Terman, *op. cit.*

children in a better way if they are not born when the parents are too young. It is to be remembered, however, that many families which produce defective children are never in a position to support offspring. The age of parents, therefore, does not seem to be a factor which has greatly influenced the growth of mentally deficient boys.

Walking, Talking, and Teething

The first tooth is an event of note, especially in the home of the first born. Walking and talking are developmental processes which to some extent indicate the rapidity with which an infant is progressing toward maturity. Talking is a social and intellectual activity, while walking and teething are chiefly physiological processes. The evidence concerning these three aspects of infancy and their relation to the mentality of the child is still somewhat disputed. Table XVI gives the mean walking, talking, and teething ages for mentally deficient boys. These data are dependent upon the statements of parents and are obviously faulty. The tendency among parents is usually to make the child seem as precocious as possible. It is, therefore, probable that any error which occurs would tend to keep the averages lower rather than make them higher.

These data seem to indicate a relationship between the degree of mental defect and the average age of walking. Idiots were more than ten months later than morons in learning to walk. There is no difference between the means for talking in classes A and C. These two groups are represented by a small number of subjects. Idiots who never talked were not included in the tabulations. It is possible that the results are not typical of the entire group with respect to the acquisition of speech. Subjects in Class B learn to talk at a much later average age. The sampling for teeth eruption is too small to obtain significant results between the groups. The earlier eruption of teeth among idiots is just the reverse of their relative walking age. It is not in line with other findings of the study. There is a belief on the part of some medical men that syphilitic cases have a tendency to erupt teeth at an early age. The records report a greater incidence of syphilis among the moron class. It is interesting to note that one of the morons was born with teeth.

Mead studied the age of walking and talking among mental defectives at Fort Wayne.¹ His results are of particular interest since approximately one-half of the subjects used in this study are also in the Fort Wayne institution. Mead found that boys began to walk on the average at 24.8 months and began to talk at 36.4 months. These ages agree almost perfectly with the means for all subjects used in the present study. Mead also found that the average age for walking and talking among normal children was 14.3 and 15.8, respectively. Abt and others reported² that boys begin to walk at 16 months while the average age for talking is 19 months (both sexes). Terman found³ that gifted children walked one month earlier than Mead's normal subjects and talked three months earlier. McCormick studied 100 Laboratory School children and found⁴ the mean age for walking, talking, and teething to be 13.8, 14.4, and 7.6 months, respectively. These means are lower than was found by Mead for normal children, and very much lower than the means for mentally deficient children.

¹ Cyrus D. Mead, "The Age of Walking and Talking in Relation to General Intelligence," *Pedagogical Seminary*, XX (September, 1913), 460-84.

² Isaac Abt, Herman M. Adler, and Phyllis Barthelme, "The Relationship Between the Onset of Speech and Intelligence," *Journal of the American Medical Association* XC (November, 1929), 1351-55.

³ Terman, *op. cit.*, p. 187.

⁴ J. Scott McCormick, "The Relation of Intelligence to Age of Walking, Talking, and First Teeth," Study filed in the Records Office of the University of Chicago Laboratory Schools.

TABLE XVI

THE AVERAGE AGE IN MONTHS AT WHICH MENTALLY DEFICIENT BOYS WERE REPORTED TO HAVE WALKED, TALKED, AND ERUPTED THEIR FIRST TEETH

Class	Walking			Talking			Teething		
	N	Mean	S. D.	N	Mean	S. D.	N	Mean	S. D.
Idiot	145	30.20	15.68	46	27.15	21.29	46	8.22	3.04
		$\pm .88$	$\pm .62$		± 2.12	± 1.50		$\pm .30$	$\pm .21$
Imbecile	184	24.32	12.73	118	39.42	20.38	61	10.91	6.64
		$\pm .63$	$\pm .45$		± 1.27	$\pm .89$		$\pm .57$	$\pm .41$
Moron	141	19.97	10.25	64	27.06	14.02	53	10.18	6.58
		$\pm .58$	$\pm .41$		± 1.18	$\pm .84$		$\pm .61$	$\pm .43$
All Classes	470	24.83	13.82	228	35.84	19.75	160	9.75	5.63
		$\pm .43$	$\pm .30$		$\pm .88$	$\pm .62$		$\pm .30$	$\pm .21$

The evidence seems to be sufficient to justify the conclusion that mentally deficient boys are significantly retarded in walking and talking. The average feeble-minded boy may be expected to walk near his second birthday, and to talk by the time he has reached the age of three. The average retardation is approximately six months for walking and eighteen months for talking. The evidence concerning teething is inconclusive as far as the present data are concerned. Cattell found no clear cut difference for the feeble-minded or dull subjects.¹

Illness and the Mortality Rate

Illnesses.— Mentally deficient males have been found to deviate negatively from normal and superior children in ultimate size and in their rate of growth. Inferior heredity and low social status without doubt have some influence on the growth of the child. There is a feeling on the part of many people that the illnesses suffered by aments are so numerous and so severe that any deviations which occur may be attributed to these environmental factors. It should be pointed out at once that there is no evidence to show whether mentally deficient individuals are weaker than the average because they have diseases or whether they have many diseases because they are biologically a lower type of organism.

The medical history of each subject was carefully examined. A record was made of all illnesses which had been reported. It is apparent that many of the illnesses in early childhood have not been recorded. Disorders which occurred while the subjects were in the institution were obtained easily. The reader should bear in mind that individuals with severe illnesses, such as: tuberculosis, epilepsy, and various disorders which require hospitalization, were not included in the study. All individuals who were segregated because of contagion or a crippled condition have been omitted. The data available have been presented in Table XVII, with the hope that some trends might be indicated. In each instance, N represents the number of different subjects afflicted. There is no repetition of the same illness for the same subject.

There is a small difference between the percentage of infectious diseases among the three classes. Idiots are slightly the most susceptible to infection. Chicken-pox, influenza, and whooping cough were reported for a larger percentage of the idiots. The average number of infectious diseases for the three classes is as follows: idiots 1.77, imbeciles 1.66, and morons 1.54. The greater the mental defect the greater the chance of suffering from an infectious disease.

¹ Psyche Cattell, *Dentition as a Measure of Maturity*, Harvard Monographs in Education, No. 9. Cambridge: Harvard University Press, 1928. Pp. viii + 91.

TABLE XVII

THE ILLNESSES REPORTED FOR MENTALLY DEFICIENT BOYS

	Class A		Class B		Class C		All Subjects	
	N	Per Cent	N	Per Cent	N	Per Cent	N	Per Cent
Number of Subjects	195		289		316		800	
Infectious Diseases								
Diphtheria	11	5.6	17	5.9	17	5.4	45	5.6
Chicken Pox	55	28.7	70	24.2	45	14.2	170	21.3
Influenza	45	23.1	53	18.3	32	10.1	130	16.3
Measles	102	52.3	140	48.4	149	47.2	391	48.9
Mumps	20	10.3	42	14.5	32	10.1	94	11.8
Scarlet Fever	14	7.2	25	8.7	21	6.6	60	7.5
Syphilis	4	2.1	9	3.1	20	6.3	33	4.1
Tuberculosis								
(all forms)	4	2.1	5	1.7	4	1.3	13	1.6
Typhoid Fever	2	1.0	0	0.0	1	0.3	3	0.4
Whooping Cough	82	42.0	98	33.9	94	29.8	274	34.3
Small Pox	6	3.1	7	2.4	4	1.3	17	2.1
Total	345		466		419		1230	
Mean	1.77		1.61		1.33		1.54	
Diseases of the:								
Circulatory System	8	4.1	6	2.1	18	5.7	32	4.0
Digestive System	180	92.3	282	97.6	208	65.8	670	83.8
Glands	11	5.6	18	6.2	13	4.1	42	5.3
Nervous System	84	43.1	100	34.6	42	13.3	226	28.3
Respiratory System	61	31.3	92	31.8	82	26.0	235	29.4
Skin	205	105.2	175	60.6	123	38.9	503	62.9
Urio-Genital System	6	3.1	12	4.2	10	3.2	28	3.5
Miscellaneous	76	40.0	115	39.8	113	35.8	304	38.0
Grand Total	976		1266		1028		3270	
Mean	5.01		4.38		3.25		4.09	

The second part of Table XVII reveals a much greater incidence of skin disorders among idiots. The low grades are probably more likely to receive scratches, thereby, providing an entrance for disease germs. Diseases of the digestive system are quite prevalent among mentally deficient boys. The eating habits of institutionalized individuals are relatively difficult to improve. Institutions provide food in sufficient quantity and quality, but the method of intake is difficult to manage. Nervous diseases are most prevalent among the idiot class. Epilepsy and convulsions are the most common types of nervous disorders listed.

The miscellaneous group of disorders includes all those illnesses which could not be assigned, from the record, to a definite part of the anatomy. For example, hernia, infection, and ulcer have little meaning in isolation. Such disorders have been grouped together as miscellaneous. When all of the illnesses, irrespective of kind, were combined, it was found that the average number of different illnesses was as follows: idiots 5.01, imbeciles 4.38, morons 3.5, and all subjects 4.09. These data indicate that the incidence of disease is associated with the degree of mental defect.

The lower grades have more illnesses than imbeciles or morons. Comparable data are not available for the incidence of the various illnesses among normal children. The illnesses reported¹ for gifted boys exceed those recorded for mental defectives. The discrepancy in this respect is probably due to a difference in the completeness of the record rather than a difference in the frequency of illness. The death rate among defectives will throw some light on the problem.

Mortality among mentally deficient individuals.— The United States Public Health Reports show that the death rate among mentally deficient males was 23.6 in 1930, as compared with a death rate of 11.3 for the total population.² Mentally deficient patients die much earlier than the average individual. Pollock found the most common causes of death among defectives to be: tuberculosis, epilepsy, pneumonia, diarrhea, enteritis, influenza, and nephritis.³ Dayton has made a very exhaustive study of the life expectancy of mental defectives in Massachusetts.⁴ It was found that only 376 idiots, out of each 1,000 born, survive until the age of ten. Three hundred and fourteen imbeciles, per one thousand, 705 morons, and 803 of the general population reach the age of ten in the state of Massachusetts. The death rate is reported as 40.7 for idiots, 21.2 for imbeciles, 6.5 for morons, 20.2 for all types of aments, and 8.6 for the general population in Massachusetts.

These data make it perfectly clear that the death rate is associated with the degree of the mental defect. The mortality rate is five times as great for idiots as for the general population. Since many of the mentally deficient persons die in the early years, the results which are reported in this study are typical only of aments who have survived long enough to be committed to state institutions. If the fittest survive, the selection which takes place tends to raise the mentally deficient group toward the normal in physique. The deviations which have been discovered in the growth process might have been much greater if a larger proportion of the aments had reached maturity. These data are inadequate to determine which is cause and which is effect. The results show that mentally deficient boys suffer many illnesses, have a high mortality rate, and both of these features are related to the degree of the mental defect.

Congenital Types of Deficiency

The data collected were intended to be a cross-section of the usual types of mental defectives found in state institutions. No subject was rejected who was relatively well physically, able to submit to the measurements, and within the age limit. The question has been raised as to the relative proportion of mongols and cretins in such a population. Only one subject was measured whose record stated specifically that he was a cretin, although a small number of subjects had cretin characteristics. A few subjects had some slight glandular disturbances. Twenty-two boys were diagnosed as typically mongolian, which is a smaller number than might have been expected. There were additional subjects who had some mongol characteristics but they could not be classified definitely as mongolians. These twenty-two mongols

¹ Terman, *op. cit.*, p. 190.

² United States Public Health Reports, United States Public Health Service, United States Treasury Department, Vol. 47, July 1, 1932. Washington, D. C.: Government Printing Office, pp. 1440-41.

U. S. Public Health Reports, United States Public Health Service, U. S. Treasury Department, Vol. 47, No. 32, August 5, 1932. Washington, D. C.: Government Printing Office, p. 1649.

³ Horatio M. Pollock, "Feeble-minded in Institutions in the United States," *Mental Hygiene*, X (October, 1926), 804-10.

⁴ Neil A. Dayton and Others, "Mortality and Expectancy of Life in Mental Deficiency in Massachusetts," *New England Journal of Medicine*, CCVI (March, 1932), 555-70 and 616-31.

will be analyzed in greater detail as a type of congenital deficiency.

It is important in the first place to correct a general misconception. At least 50 per cent of the mongolians are imbeciles and not idiots. Brousseau uses the term mongolian imbecility consistently.¹ A description of one typical mongol characterizes the entire class. Bean gives one of the best concise descriptions of mongolism.²

Their chief characteristics are small stature, great relative sitting height, short arms and legs, broad and short hands and feet, single transverse head lines, short thumbs and short incurved little fingers, the middle phalanx shorter than the terminal, prehensile great toes, small ratio of lower to upper arm length, small span and chest girth, high omphalic index, markedly broad and short head which is globular and sometimes flattened behind, involuted ears with adherent lobules and overturned upper helix, nose of the Hypomorph type, mongoloid eyes, laxity of muscles, over flexible joints, presence of the metopic suture, wide open sutures with fontanelles, small epiphyses which remain ununited late, simple gyri and sulci of the cerebrum with small cerebellum and brain stem, rough, dry skin, scrotal tongue, defective retina and impaired vision.

Bean calls attention to the fact that,

Mongolism is not so much abnormal development as incomplete metamorphosis the cells seem to be unfinished or imperfect The epiphyses of the bones are small and unite late if at all.³

Bean reviews the causes assigned for mongolism and shows that the endocrine glands have been brought in "as a cover for ignorance and negligence." He concludes with the statement, "This all seems to mean that nobody knows the cause of mongolism and anybody's guess is as good as another's."⁴

A study of thirty-one mongolians by Kuenzel shows⁵ that there are variations in general appearance of such a definite type of amentia as a mongol. Some of the traits observed in rank order of differentiation are:

- | | |
|------------------------------------|-------------------------------------|
| 1. Almond shaped eyes | 9. Hyperflexible joints |
| 2. Flattened occiput | 10. Assumes tailors position |
| 3. Depressed nasal bridge | 11. Shallow eye sockets |
| 4. Pointed tongue | 12. Very wide distance between eyes |
| 5. Unusually long tongue | 13. Chapped hands |
| 6. Deeply fissured tongue | 14. Dry skin |
| 7. Somewhat depressed nasal bridge | 15. Many fissures in tongue |
| 8. Transversely fissured tongue | (fifteen other traits were listed) |

The average age of fathers, at the birth of the twenty-two mongolians analyzed in this study, was 38.9 as compared with 34.1 for all types of mentally deficient subjects. The average age of mothers was 34.6 as com-

¹ Kate Brousseau, Mongolism. Baltimore: Warwick & York, 1928. Pp. viii + 210.

² R. Bennett Bean, "Some Anatomical Characteristics of the Mongolian Imbecile," Training School Bulletin, Vol. XXII, No. 2, Whole Number 223 (April, 1925), 17-20.

³ Ibid.

⁴ Ibid.

⁵ Myra Kuenzel, "A Survey of Mongolian Traits," Proceedings of the American Association for the Study of the Feeble-minded, XXXIV (May, 1920), pp. 149-60.

pared with 27.7 for all subjects. Ten fathers were more than forty years of age, three were above forty-five, while five were thirty or younger. Five mothers were above forty years of age at the birth of the child, while seven were thirty or younger.

The average birth order was 4.6 for mongols and 3.3 for all mentally deficient boys. Two of the mongols were first born, while nine were the last child. Seven were born into families with more than five children.

There seems to be some relationship between the age of parents, birth order, and mongolism. Brousseau concluded from a study of a large number of mongols¹ that advanced age of parents is not necessarily associated with mongolism but may contribute to it. Birth order did not appear to be significantly related to mongolism in Brousseau's data.

The issue in the present study concerns the growth rate of mongolians and their influence upon the results of the entire mentally deficient group. Eleven of the twenty-two mongols were classified as imbeciles. There were no more than four mongolians at any one age. The twenty-two subjects ranged in age from eight to twenty. Thus, there is little chance that the mongolian group has significantly influenced the results at any age or in any class.

Means were calculated for the physical measurements of the twenty-two mongolians. The mean C. A. of the group was 12.4, thus it seems that a comparison with the average 12 year-old mentally deficient boy would be most fair. The results obtained are given in Table XVIII.

Mongols are insignificantly shorter than the average mentally deficient boy. The difference in arm span, 119 ± 22.4 , is significantly in favor of the average mental defective. Sitting height is slightly in favor of the mongols. Mongolians are significantly heavier than the average defective subject. Chest development, particularly chest depth, is superior in the mongol group. There is no significant difference in hip width. The mongols' heads are quite small with a definite brachycephalic development. Maturity as judged by skeletal-months ratings and the ossification ratios is approximately the same as the average mentally deficient boy.

The mongolian must not be described as a small individual when compared with other mental defectives. His extremities, arms, legs, and digits, are much shorter than the average. His trunk development, on the other hand, equals or exceeds that of his fellow inmates. His head is definitely shorter but only slightly narrower and flatter. The body build of the mongol differs from other mentally deficient subjects but the inclusion of these twenty-two mongols in a group of eight hundred subjects has no significant influence on the means. The proportion of typical mongolians and cretins among the average mentally deficient population appears to be smaller than has been generally supposed.

The data presented in this chapter show that the family stock of mentally deficient children is liberally weighted by parents who are mentally deficient, economically poor, socially low, occupationally inferior, and morally degraded. There are parents who come from good stock and fill places of importance in society. A blanket statement that mental deficiency is heritable in a Mendelian ratio has been seriously questioned by eminent authorities. Birth abnormalities which result in brain injury seem to produce the same general effect on growth as congenital deficiency, with the exception of a greater incidence of paralysis among injured subjects. Parents of idiots are older at the birth of the child than the average for all classes, but the reason for this phenomenon is not clear. The average age of all parents does not seem to be significant. Approximately one quarter of the

¹ Brousseau, op. cit.

TABLE XVIII

A COMPARISON OF THE TWENTY-TWO MONGOLIANS WITH THE AVERAGE
MENTALLY DEFICIENT BOY

Variable	Mongols	Means for all Subjects
Standing Height ...	1370 $\pm$ 13.7	1379 $\pm$ 6.54
Arm Span	1247 $\pm$ 21.3	1366 $\pm$ 7.00
Sitting Height	729 $\pm$ 9.8	722 $\pm$ 3.00
Weight	48 $\pm$ 1.9	32 $\pm$ 0.50
Chest Girth	691 $\pm$ 11.3	652 $\pm$ 3.60
Chest Depth	198 $\pm$ 1.3	149 $\pm$ 1.20
Chest Width	208 $\pm$ 3.7	205 $\pm$ 1.10
Hip Width	217 $\pm$ 3.6	216 $\pm$ 1.30
Head Length	164 $\pm$ 1.3	179 $\pm$ 0.70
Head Width	139 $\pm$ 0.7	141 $\pm$ 0.60
Head Height	114 $\pm$ 0.7	118 $\pm$ 0.50
Skeletal Months ...	139 $\pm$ 6.0	133 $\pm$ 1.60
Ossification Ratio	77 $\pm$ 3.8	80 $\pm$ 1.20
Chronological Age	12.4	12.0

mentally deficient boys are first born. They come from a family of five children, thus it appears that there is a greater incidence of deficiency among first born children. Mentally deficient boys walk and talk later than the average for normal children. The age of walking seems to be related to the degree of defect. Each subject has had an average of more than four illnesses. There is a definite relationship between the number of illnesses and the mental level. The mortality rate is approximately twice as high among mentally deficient persons as among the general population, while idiots have a death rate which is nearly five times as great as the average for the general population. Mongolism is a condition which produces a different body type. These subjects are up to or above the average of their group in some respects and far below in the length of the extremities.

These data show that there are many environmental and hereditary factors which are directly associated with growth. Which is cause and which is effect is impossible to determine from the present data. The general weight of evidence suggests that mental deficiency is a condition which affects the whole organism. Mental defectives are, therefore, inferior to the general population both in physical and mental characteristics.

CHAPTER VI

ANOMALIES OF DEVELOPMENT

Mental deficiency implies, when considered alone, a defective central nervous system. If the defect were confined to the nervous mechanism, it is conceivable that the development of other parts of the body would be normal. A large share of aments are, however, the product of a defective germ plasma. These inferior cells usually come from weak-minded parents but they may be carried in the bodies of apparently normal individuals. A conception which produces a mentally deficient child, in a family with the best environment, may be traceable to a germinal condition. The question is raised whether the deficiency is a condition which spreads over the entire organism? Are there physical anomalies which accompany amentia? It is the purpose of this chapter to consider the so-called "stigmata of degeneracy", including bone anomalies, anthropometric deviations, and certain special cases.

Stigmata of Degeneracy

The consensus of opinion places a large number of physical defects upon the mentally deficient person. Physical deviations and malformations have come to signify to some writers a degenerated condition. Stigmata of degeneracy have been discussed, tabulated, classified, and illustrated.¹ Wertham recorded anomalies among 923 psychopathic individuals.² His tabulation revealed that 21 per cent of the subjects had growth disorders. The following types of defects were noted: skeletal abnormalities, asymmetries, malformation, genital anomalies, skin defects, abnormal distribution of fat, and hair anomalies. The incidence of developmental defects is probably greater for aments as a class than when they are included with demented.

Barr considered stigmata to be extremely important. He says,

That stigmata are not only present, but prove a valuable aid in the diagnosis of mental defect, there can be no doubt. But one can not point to any single deviation from the normal and say positively that it alone is peculiar to any special defect. It is equally true that many perfectly normal people exhibit some stigmata; but never in such combinations as do defectives. Thus a single anomaly in an individual is not indicative of degeneration; but a combination of three or more will naturally lead the investigator to look for associated mental and moral defects, as in accordance with the now accepted theory, the individual exhibiting from three to five stigmata should be classed as defective beyond peradventure.³

It is interesting to note that one stigma has no diagnostic value but that, according to "the now accepted theory", three or more constitute ample evidence that the individual has a mental deficiency. Barr failed to find any peculiar types of stigmata which have diagnostic significance.

It should be remembered that superior children are not free from physical abnormalities. Terman reported⁴ that 11 per cent of the gifted chil-

¹ A. F. Tredgold, Mental Deficiency. New York: William Wood Company, 1929. Pp. xvi + 535.

² F. I. Wertham, "Incidence of Growth Disorder in Nine Hundred and Twenty-Three Cases of Mental Disease," Archives of Neurology and Psychology, XXI (May 1929), 1128-40.

³ Martin W. Barr, "Observations on the Stigmata of Degeneration as Found in Feebleminded," New York Medical Journal, CXII (July 17, 1920), 80-83.

⁴ Terman, op. cit., p. 249.

dren had defective hearing, 11 per cent of the boys had defective vision, seven-eighths of the group had defective tonsils, 6.1 per cent had hyperthyroidism, but genital abnormalities were rare. Terman very aptly cautions¹ that the number and kind of anomalies observed depend upon the person who makes the examination. Normality is only relative, therefore, the personal equation has a very definite relationship to stigmata.

Case reviews the literature on anomalies of the palate as related to amentia.² She shows that various writers have reported abnormal palates among defectives ranging from 10 to 82 per cent of the subjects. Her results from careful measurements show that the size of the palate is related to the size of the head but normal individuals have as much asymmetry as mentally deficient subjects.

Englebach and McMahon found³ that disturbances of the endocrine system produce serious physical abnormalities. Hypothyroidism causes delayed development. Hypogonadism and eunuchoidism consistently produce late epiphyseal fusion. Pituitary insufficiency also causes delayed epiphyseal closure. Development is greatly accelerated in pubertas praecox, which has been associated with malfunctioning of the pineal gland. Glandular functioning is probably closely associated with mental deficiency.

Two studies⁴ call attention to another type of anomaly, Stevenson says, "the feeble-minded show many anomalies of form and function of the gastrointestinal tract with no characteristic single anomaly."⁵ He says further, "There is but one conclusion, feeble-mindedness is no entity; it must be considered as a disease of the deficiency group. It probably has a varied etiology."

A very comprehensive study was made by Burke⁶ with 3,000 mentally deficient subjects. He says,

There is no doubt that mental defectives are poor specimens of the genus *Homo* Indeed it is permissible to suggest that the defective is an example of development whose anomaly is generalized rather than localized.

Burke reported: 14 cleft palates, 3 hare lips, 38 ear malformations, many teeth defects, 6 cases with supernumary nipples, and five individuals with webbed digits. His results did not show that defects were more common among lower-grade individuals. Burke's review of the literature on stigmata led him to conclude that "they were the results of different people under different conditions with different standards."

Myerson listed the defects among 535 persons as follows:⁷ 24 were so short that they were classified as dwarfs, 17 were blind, 18 were deaf, 21 had signs of organic brain disease, 121 presented so many signs of inferiority that they were called abnormal, 33 had vaso-motor disturbances, and 44 had marked cranial deformities. He concludes, "It may be stated as a general proposition that the institutional feeble-minded are feeble-bodied as well."

¹ Terman, op. cit., p. 25.

² Case, op. cit.

³ Englebach and McMahon, op. cit.

⁴ Jatho and Lundlun, op. cit.
Stevenson, op. cit.

⁵ Stevenson, op. cit.

⁶ Burke, op. cit.

⁷ Myerson, "Pathological and Biological Basis of Mental Deficiency," op. cit.

The existing literature reveals a high incidence of anomalies, but there is no attempt to label certain types of defects as symptomatic of mental deficiency. The only relationship of any importance seems to be the number of malformations rather than the kind. The available results argue for a general bodily deficiency rather than a localized defect.

A total of 139 boys in the present group of 800 subjects were recorded as free from physical defects. Four types of records were available for each subject, namely, medical diagnosis, anthropometric measurements, carpal roentgenograms, and the inspectional record made by the writer. It is, therefore, apparent that a deficiency would very likely show up in one of these four categories. The 139 apparently well-developed subjects were distributed as follows: 12 idiots, 57 imbeciles, and 70 morons. Thus 6.2 per cent of the idiots, 19.7 per cent of the imbeciles, and 22.2 per cent of the morons were listed as free from developmental anomalies. Subjects at the higher mental levels appear to have a greater chance of falling into the group with no observable physical abnormality. The idiot is indeed rare who does not possess at least one developmental abnormality. The types of deviations observed and reported are given in Table XIX. Since illnesses and pubescent deviations have been reported previously, they have been omitted in the present consideration. These data, as presented in Table XIX, are exclusive of the twenty-two mongolian subjects.

There appears to be no particular type of anomaly which is associated with a given class of mental deficiency. The total of all anomalies for each class shows a relationship between the degree of the mental defect and the number of physical abnormalities. Idiots have an average of 2.66 physical defects, imbeciles 1.87, and morons 1.52. Some of the most frequently mentioned anomalies were as follows: exaggerated reflexes 108, scars 96, pot belly 88, short digits 56, irregular teeth 48, carious teeth 44, and 40 boys with sluggish reflexes. There were four subjects with hydrocephalus and two with microcephalus. Three subjects had hare lips and seven had cleft palates. The low hair line, so often associated with mental deficiency, was observed in only six instances. These data are in agreement with the literature in so far as they indicate that the so-called stigmata of degeneration do not serve as an adequate basis for diagnosing mental deficiency. Anomalies are very frequent among the mentally deficient population and seem to be most common for individuals at the lower levels of intelligence.

A description has already been given of the physical appearances of mongolians. It would be repetition to dwell upon such anomalies at this point. Special attention will be given to some of the more unusual types of deviation.

Bony Malformation in the Hand

Carpal roentgenograms made it possible to observe certain internal bone anomalies as well as to determine the degree of development. Some of the most striking bony malformations will be illustrated.

Extra epiphyses and fused bones.— Two very different types of malformation were observed. There were some hands with extra epiphyses or a double bone nucleus, while other subjects showed a reduction in the number of bones. Turner reported¹ that the following variations have been observed in the dissecting room: (1) Coalescence of the trapezium (m. majus) and scapoid (naviculare) in the left hand of a man; (2) Division of the trapezium in the left hand of a woman; (3) Division of the trapezium in the right hand of a man; (4) The styloid process of the third metacarpal was a distinct osside. Thus, it appears that in rare instances a decrease or

¹ William Turner, "Some Variations in the Bones of the Human Carpus," Journal of Anatomy and Physiology, XVII (January, 1883), 244-49.

TABLE XIX
ANOMALIES OF DEVELOPMENT IN 778 SUBJECTS

Type	Class A	Class B	Class C	All
Osseous:				
Skull	35	35	29	99
Teeth	61	67	106	234
Palate	4	1	5	10
Carpus	47	35	25	107
Spine	8	7	6	21
Chest	13	23	13	49
Digits	33	49	32	114
Sense Organs				
Eyes	22	22	8	52
Ears	10	7	12	29
Lips and tongue ..	7	1	2	10
Nose	0	1	1	2
Skin	29	48	45	122
Reflexes	42	62	44	148
Body Proportion	38	40	36	114
Nervous	27	32	29	88
Genital	16	17	22	55
Locomotion	23	13	3	39
Other	74	61	61	196
Total	489	521	479	1489
Mean for all Subjects	2.66	1.87	1.52	1.91
Mean for Subjects with Anomalies ...	2.84	2.46	1.95	2.33
Number of Subjects ..	184	278	316	778
Number with Anomalies	172	221	246	639

an increase in the number of carpal bones may be observed. Figures 40, 41, 42, and 43 illustrate four types of deviations which have been observed in the carpus.

Twenty-seven of the 800 roentgenograms had pseudo-epiphyses on the base of the second metacarpal. Three of these individuals had the suggestion of such an epiphysis on the proximal end of the fifth metacarpal. Nine subjects were found in each of the three classes. Figure 40 illustrates the pseudo-epiphysis on the base of the second metacarpal. Figure 43 illustrates extra epiphyses on the first, second, and fifth metacarpals. The writer has 527 roentgenograms of normal preschool children. These normal children had a total of 23 pseudo-epiphyses on the proximal end of the second metacarpal. It appears that this trait is not a phenomenon linked with mental deficiency.

There is no adequate explanation in the literature for these extra epiphyses. In the early days of the x-ray, the debate was on to determine whether the epiphysis on the proximal end of the second metacarpal was typical or pseudo. The nature of the discussion is well illustrated in an article by Michaelis.¹ He pointed out that the evidence was still inconclusive and suggested that a large number of x-rays be taken to solve the

¹ R. Michaelis, "Basale Epiphyse des Metacarpale II," *Zeitschrift für Morphologie und Anthropologie*, VIII (1904-05), 80-86.



Figure 40.- A pseudo-epiphysis on the second metacarpal.



Figure 41.- The styloid process is split off of the ulnar epiphysis.



Figure 42.- A fused capitatum and hamatum.



Figure 43.- A fused triquetrum and lunatum.

problem. Several later German writers have done additional work on pseudo-epiphyses. Josefson and Rochlin both have found that pseudo-epiphyses are directly related to endocrine disturbances.¹ There is no evidence to show that the incidence is greater among mental defectives than among normal children.

Several subjects were observed at the younger ages in which a bone nucleus had a double center. Since none of the subjects had a double bone at maturity, it is probable that these two centers were later united. Eight roentgenograms were observed in which the styloid process was split off of the ulnar epiphysis. This abnormality might have been the result of a fracture, but it is unlikely that 1 per cent of the subjects would have had the same kind of a fracture at any given time. An abnormal ulna is shown in Figure 41. The reason for this condition is not clear. The writer has found no reference to any such anomalies in the literature. It is an anomaly which is certainly relatively rare.

Seven roentgenograms were discovered in which two of the carpal bones appeared to be fused. Two subjects showed fusion of the capitatum and the hamatum, while five hands had a fused triquetrum and lunatum. Figures 42 and 43 illustrate these conditions. The cause for such deviations from the normal has not been discovered. There are a few cases on record in the literature, which exhibited the same type of disorder. Turner reported² the fusion of the m. majus and the naviculare. Smith found a fused triquetrum and lunatum in both hands of a male negro.³ He also quoted Thompson and Sommering to the effect that previous cases had been found. Derry examined a number of skeletons in medical college at Cairo, Egypt, and found two instances of carpal fusion.⁴ One case was a male and the other a female. In both of Derry's cases the fused bones were the lunatum and the triquetrum. The literature indicates a greater incidence of fusion for the triquetrum and the lunatum. Five of the seven fusions discovered in the present study involved these two bones. The writer has failed to find any previous record of fusion of the capitatum and hamatum. Carpal fusion is not confined to negro skeletons as some authors have suggested. Although carpal fusion has been observed, it is relatively rare for the writer examined more than six thousand roentgenograms of normal children without finding a single instance of the anomaly. The appearance of only seven fusions among 800 mentally deficient subjects indicates that the incidence has little diagnostic value.

Malformed bones and abnormal carpal areas.— Malformations may occur in particular bones or in the general developmental condition of the entire carpal area. Figures 44, 45, 46, and 47 illustrate two types of bone malformation and two extremes in the development of the carpus.

The most commonly observed anomaly in bone shape was the length of the naviculare. Thirteen boys, all idiots, had excessively long naviculares. One of these roentgenograms is reproduced in Figure 44. Neither the cause nor the significance of this condition has been determined. It is at least interesting to note that all of these subjects were in the idiot group.

¹ Arnold Josefson, "Die Pseudoepiphysen ein Stigma der endokrinen Hemmung des Skelettenwachstums," Fortschritte auf dem Gebiete der Roentgenstrahlen, XXIV (1916), 266-68.

R. G. Rochlin, "Über die Pseudoepiphysen und deren Bedeutung in der Endokrinologie," Zeitschrift fuer Anatomie und Entwicklungsgeschichte, LXXXII (1927), p.354.

² Turner, op. cit.

³ G. E. Smith, "On a Case of Numerical Reduction of the Carpus," Anatomischer Anzeiger, XXIII (August, 1903), 494-95.

⁴ Douglas Derry, "Fusion of the Carpal Bones," Journal of Anatomy and Physiology, XVI (1907), 56-58.

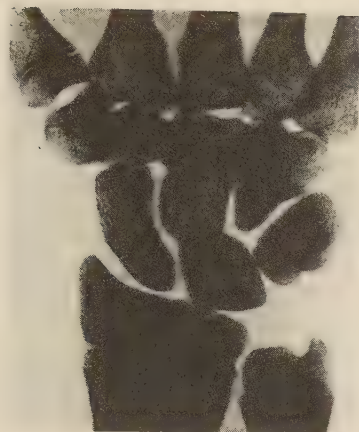


Figure 44.- An extra long naviculare.



Figure 45.- A malformed second metacarpel head.



Figure 46.- A twenty-year-old boy with much open space in the carpal area.



Figure 47.- A seventeen-year-old boy with a crowded carpal area.

There were five roentgenograms in which the second metacarpal head was malformed, but each of these subjects was past his twentieth birthday. It is possible that the condition is a result of an injury rather than an anomaly of growth. The abnormality is illustrated in Figure 45.

The fifth phalanx in the second row was very short in six instances. This condition could have been the result of an accident but the chances seem to be in favor of abnormal development. If accidents had produced the condition, it is likely that at least a portion of the hands would have carried some marks of the injury in other phalanges. An explanation of the short phalanx is not warranted from the present data. See Figure 40 for an illustration of the short fifth phalanx.

The normal hand develops in such a manner that the roentgenogram shows little open space and much overlapping of shadows in the carpal area at maturity. Mentally deficient subjects deviate in both directions from the normal. There is a tendency in the negative direction, however. Two prints are shown in Figures 46 and 47 with much open space and a crowded carpal area, respectively. The case used for Figure 46 is a typical mongol, age twenty, open space in the carpal area, short phalanges, pot belly, sores all over the body, webbed toes, and a high-grade idiot. The case in Figure 47 is seventeen years of age, a high-grade imbecile, with the following anomalies: crowded carpal area, large ears, long faced, with asymmetrical development toward the right, pigeon chested, hyperactive reflexes, scoliosis, and suspected arrest of hydrocephalus. A massed carpal area is relatively rare among mentally deficient males. Open space in the carpus is rather typical of the mongolian and is much more common among defectives than with normal individuals.

An extremely abnormal roentgenogram is shown in Figure 48. This subject is a twenty-three-year-old idiot with the following anomalies: short digits, webbed fingers, overlapping fourth toe, short chubby feet, prominent shoulder blades, crowded teeth, malformed ears, acne, excessive hair on the body, carpal bones small and malformed, and mutism. It is clear that the abnormalities which appear in the x-ray are only a part of the picture of a generally malformed individual.

Abnormal epiphyseal closure.— There is disagreement in the literature concerning the time of epiphyseal closure. No writer, however, has placed the date beyond the age of twenty. Twelve subjects out of 113, who were twenty-one years of age and older, showed epiphyses in the hand which had not yet closed. Seven of these individuals were idiots, four were imbeciles, and only one was a moron. Figure 49 illustrates an extreme subject among the idiot group. The case history reveals no serious illness which might have produced the delayed development. The patient is twenty-two years of age and has had institutional care for the past ten years. There were no other physical anomalies except lordosis. Case No. 711 has an IQ of .05, weighed 38.2 kilograms, was 146 centimeters tall, and had a sitting height of 76.4 centimeters. The twelve subjects who were much retarded in epiphyseal closure may have suffered from glandular insufficiency as Englebach and McMahon have suggested.¹ Clift has followed² the development of mentally deficient individuals at the Michigan State School who were known to have some glandular disorder. He found that endocrine disturbance may cause either accelerated or delayed ossification. The retardation frequently manifests itself in late epiphyseal closure. His work is in substantial agreement with the findings of Englebach and McMahon.³

Five subjects were noticed with marked acceleration in epiphyseal

¹ Englebach and McMahon, *op. cit.*

² Clift, *op. cit.*

³ Englebach and McMahon, *op. cit.*



Figure 48.- Extreme abnormality in the development of the hand of an idiot.



Figure 49.- An idiot with open epiphyses at the age of twenty-two.

development. Case No. 289, in Figure 50, illustrates early development in a mentally deficient subject. This case is fourteen and a half in chronological age, a low-grade imbecile, who shows no serious physical deficiency. He is nearly up to the average height of the mentally deficient adult, but is 17 kilograms lighter than the average twenty-year-old subject.

Skeletal deviations in roentgenograms for mongolians.- Mongolian subjects were not included in the discussion of anomalies. Their anthropometric deviations have been discussed previously. The anomalies noted in the development of the hands of the twenty-two mongolian subjects are as follows:

Case No. 832, C. A. 6, Class A. - Four bones present, one epiphysis, about two and a half years retarded.

Case No. 606, C. A. 8, Class B. - Short fifth phalanx in the second row.

Case No. 689, C. A. 8, Class B. - Digits short, open space.

Case No. 869, C. A. 9, Class B. - Approximately normal.

Case No. 335, C. A. 10, Class B. - Curved little finger, pseudo-epiphysis on the second metacarpal, open space.

Case No. 76, C. A. 10, Class B. - Small m. majus, near normal.

Case No. 302, C. A. 10, Class B. - Accelerated carpal development, pisiforme present, also styloid process on the ulna.

Case No. 303, C. A. 12, Class B. - Bones are malformed but the development is near normal.

Case No. 249, C. A. 12, Class A. - Bones small, much open space, metacarpal heads small.

Case No. 307, C. A. 12, Class A. - Open space and small bones.

Case No. 345, C. A. 12, Class B. - Open space and small bones but development is ahead of the size, metacarpal heads small.

Case No. 678, C. A. 13, Class A. - Small hand, development near normal.

Case No. 332, C. A. 13, Class A. - Near normal.

Case No. 650, C. A. 14, Class B. - Bones small, development ahead of the size, pseudo-epiphysis metacarpal II, open space.

Case No. 527, C. A. 14, Class B. - Bones small, open space, development ahead of the size, sesamoids, I, II, and V.

Case No. 290, C. A. 14, Class A. - Bones small, early closure of epiphyses, near maturity, sesamoids, I, II, and V.

Case No. 600, C. A. 15, Class B. - Small bones, much open space, curved little finger, near normal in development.

Case No. 348, C. A. 15, Class A. - Small bones, open space, much retarded.

Case No. 340, C. A. 15, Class A. - Short phalanx second row fifth, early closure of epiphyses, accelerated, sesamoids, I, II, and V.

Case No. 337, C. A. 15, Class A. - Small bones, open space, three years retarded.

Case No. 330, C. A. 17, Class A. - Curved little finger, small bones, retarded.

Case No. 729, C. A. 20, Class A. - Mature, small bones, open space, short digits, curved little finger.

The mongol hand may show much open space in the carpal area but the stage of development reached for the group is not greatly below the normal for their age. The individual variations among mongols are wide. Some of the subjects are accelerated, while others are much retarded.

Normal osseous development among feebleminded boys.- The question was raised at the outset as to the time when mentally deficient males reach maturity. The writer thought that there might be certain types of mental defectives who would remain at an immature stage of ossification until far past the average age for maturity. A number of the subjects were up to the



Figure 50.- A feebleminded boy who shows marked skeletal acceleration.

norm in carpal development. Case No. 437, in Figure 51, illustrates a well developed carpus in a high grade moron. This boy appeared to be normal in his physical development. His height and weight are slightly above the average for the mentally deficient group at maturity, although he was only four months past his seventeenth birthday. In skeletal-months evaluations he was up to his chronological age. He is an excellent representative of the well appearing mentally deficient individual.

Idiots were found to reach maturity before their twenty-fifth birthdays. Case No. 737, in Figure 52, shows a mature idiot at the age of twenty-six. His physical examination was negative. He is taller than the average mature mental defective, but weighs only fifty kilograms. It is interesting to note the long naviculare in this case. The writer x-rayed fifty idiots who were past twenty-five years of age to determine whether there are individuals who have not reached maturity at the more advanced ages. There was not a single subject with open epiphyses or an absence of a carpal bone after the age of twenty-five. It appears, therefore, that even the lowest grades of mentally deficient persons do finally reach skeletal maturity. The writer extended the data to age twenty-five with the hope that the limits of immaturity would be covered. The results show that a study of mentally deficient persons which extends to the age of twenty-five will allow sufficient time for all subjects to have reached maturity. Any age prior to that point would have been unsatisfactory.

Anthropometric Deviations

Anomalies of development which are revealed by anthropometric measurement might be treated in several ways. An attempt has been made to select cases which will illustrate the most extreme types of deviation. Two cases were diagnosed as microcephalic by the examining physician. These two cases were considered of sufficient importance to deserve special attention. Two cases were observed who had very long trunks in relation to their total stature. Some method had to be used to select additional subjects with extreme anthropometric deviations. It was decided that any subject who fell outside the limits of ± 3.5 sigmas from the average for their age distribution, in any anthropometric variable, deserved individual attention. The chances were less than one that a single case would fall beyond these limits in any of the eleven measures in a sample of 800 subjects. Nevertheless, thirteen subjects were found who deviated as much as 3.5 standard deviations from the mean in some anthropometric variable. These individuals will be considered according to the type of deviation observed.

Extremes in trunk development.— Two cases with disproportionately long trunks were both twenty-one years of age. They exhibited no other serious physical abnormality. They had reached maturity in skeletal development. Case No. 752 was an idiot who weighed only fifty kilograms, while Case No. 584 was a moron and weighed sixty-nine kilograms. The moron was 1651 millimeters tall, while the idiot was only 1570 millimeters in height. The sitting heights were 901 and 900 for the moron and the idiot, respectively. At twenty-one years of age the average mentally deficient male has a sitting height which exceeds one half his stature by fifty millimeters. Case No. 584 has a sitting height which is seventy-five millimeters greater than one-half his standing height. The idiot has a sitting height which exceeds one-half his stature by 115 millimeters. The body development of these two subjects has produced short limbed individuals who are in other respects more nearly up to the average for their group. In fact these two individuals exceed the average sitting height for their age by nearly thirty millimeters, although the idiot is more than forty millimeters shorter than the average twenty-one-year-old subject.

Two fifteen-year-old subjects were observed who deviated more than -3.5 standard deviations from the mean for their age in trunk length. Both of these cases were idiots who had other types of abnormal development. Case



Figure 51.- A well developed carpus in a high grade moron.



Figure 52.- The hand of a mature idiot at the age of twenty-six.

No. 337 is a typical mongolian and needs no further description. Case No. 622 is a low-grade idiot with malformed ears, infantile genitals, and a disproportionate body build. He weighed less than 24 kilograms, which is more than eleven kilograms below the mean for fifteen-year-old mentally deficient boys. These four subjects illustrate the extreme types of trunk development which are found in mentally deficient groups of boys.

Microcephalus.— Only two subjects were diagnosed as microcephalic, one an idiot, the other a low-grade imbecile. The death rate for microcephalic individuals is high,¹ thus the incidence of this disorder is not large. Siblings and parents of microcephalic children are likely to be degenerate, according to Tredgold.² The two subjects found in this study came from good stock. Case No. 749 has seven siblings all of whom are normal. The medical history suggests a possible infantile cerebral paralysis. Case No. 867 has two normal siblings. There is only one adverse condition listed in either history. The paternal aunt of Case No. 867 was adjudged feeble-minded.

The head measurements for Case 749 are: length 164, width 113, and height 98. These dimensions are not quite 3.5 standard deviations below the mean for the twenty-two-year-old males, the age group in which the case falls. The head measurements for Case No. 867 are: length 132, width 111, and height 96. A head width of 111 is just 3.5 standard deviations below the mean for the eight-year-old group. The head height is one millimeter greater than -3.5 sigmas, and the length is two millimeters greater than negative 3.5 standard deviations. The imbecile, Case No. 867, is up to or above the average for his age in other physical measurements. Case No. 748 is in the idiot class and falls below the average for mentally deficient subjects in his age group. The head dimensions for these two cases are very significantly below the average for their group.

Abnormal head length.— Head length may be abnormally long or abnormally short. Subjects have been found to illustrate both types of deviation. The long-headed or dolichocephalic person has a cephalic index below 75. Case No. 444, with a head length of 217 and a head width of 137, falls within this classification. This subject is a fairly well developed thirteen-year-old moron, with a head length 3.5 standard deviations above the mean for his age. He is retarded slightly in carpal development but is up to the average for his age group in most of the anthropometric measurements.

Case No. 741, a low-grade idiot, has an exceedingly short head length. The head dimensions for this subject are: length 152, width 150, and height 122. These figures show that this boy is quite round headed. He is eighteen years of age, but true to the idiot type is not even up to the average for mentally deficient males in his age group. There is no apparent reason for such deviations as excessively short or long headed development. These anomalies are interesting even though they can not be explained.

Deviations in arm span.— Two subjects have been found who illustrate extreme positive and negative deviations in the growth of the arms. Mongolians would be expected to have a short arm span but only one subject was observed who deviated as much as 3.5 standard deviations from the average for his age group. Case No. 650, a fourteen-year-old mongolian imbecile, has an arm span of 1078 which is 13 millimeters shorter than a negative 3.5 standard deviations. The mongolians have already been discussed, thus it is unnecessary to repeat a description of this subject.

Case No. 120 is a well developed thirteen-year-old imbecile who has an excessive arm span. His reach is one millimeter greater than 3.5 standard deviations and exceeds his stature by 46 millimeters. These two subjects

¹ Tredgold, op. cit., p. 204 ff.

² Ibid.

serve adequately to show that the mentally deficient class is composed of individuals who vary widely in their development.

Excessive chest depth.— Cases No. 278 and No. 661, ages sixteen and twelve, respectively, exceed the mean of their age groups by as much as 3.5 standard deviations in chest depth. In both instances the chest depth is nearly as great as the chest width. Both of these boys have large ears and No. 278 has hyperactive reflexes and an abnormally long naviculare. There are no other serious anomalies reported for these subjects. Round chestedness is a deviation which may be more frequent among mentally deficient persons than in the normal population but no comparable data are available.

Feminism.— A tendency toward feminism among mentally deficient males has been reported in a previous chapter. The discussion of hip size in relation to chest width showed clearly that defective males are more likely to develop feminine body characteristics than are normal boys. Case No. 872 has a hip width of 300 which is two millimeters above 3.5 standard deviations. His chest width is 262 or thirty-eight millimeters less than his hip width. He exceeds the average fifteen-year-old mentally deficient boy by more than twenty-five kilograms in weight. His body build was easily recognized as feminine in type. There are no other anomalies reported for this boy. The only significance which the writer is able to attach to such deviations is that these individuals furnish additional evidence to support the finding of a greater heterogeneity among the mentally deficient population.

Obesity.— The fact that aments as a class are below normal in weight does not mean that all of these subjects are exceptionally light. Two brothers were measured who clearly fall in the obese class. These two cases, No. 270 and No. 287, were eighteen and twenty years of age, respectively. Both of the cases are idiots. Case No. 287 is more than 3.5 standard deviations above the mean for his group in several anthropometric measurements. Some of his dimensions are as follows: weight 118 kilograms (4.5 sigmas), chest girth 1205 millimeters (nearly 5.5 sigmas), chest depth 272 (4.5 sigmas), chest width 362 (more than 5.5 sigmas), and hip width 368 (above 3.5 sigmas). Case No. 287 measured 1315 millimeters around the abdomen, while his brother had an abdominal girth of 1173 millimeters and a calf girth of 478 millimeters. One does not need to dwell upon such data to demonstrate the obesity of these two individuals. The cause for the abnormality can not be determined from the records. Excessive weight is the exception among mentally deficient males but both extremes will be observed when a large sample is inspected.

The fifteen subjects discussed in the foregoing paragraphs are sufficiently different from the average of their respective groups to demonstrate that the mentally deficient portion of the population is probably more variable than normal individuals, partially because an excessive number of aments show extreme physical development. Anomalies are easier to identify than they are to explain. The explanations are unknown in many instances. Anthropometric deviations have been presented as a stimulus to other research workers as well as for their interest in connection with the present study.

A Special Case

The occurrence of a single anomaly is not uncommon even in the so-called normal individual. Normality is always a relative condition. There are individuals who suffer from conditions which produce marked deviations in the entire organism. The typical cretin is an illustration of a condition which produces gross physical deviation of a widespread nature. Cretins are so susceptible to infection that very few of them survive infancy without careful medical treatment. The one cretinoid observed among the subjects used in this study does not deviate sufficiently from the mean of his group to

warrant special consideration. A case of pubertas praecox was discovered which appears to deserve separate treatment.

Pubertas praecox is a condition which has received considerable attention. Paterson reviews the cases which have been reported to date.¹ Precocious pubertal development is accompanied by excessive growth in general physique. There is some tendency among physicians to associate pubertas praecox with a malfunctioning of the pineal gland.² Whatever the cause the end result appears to be in general the same, an overdeveloped physique.

The following data are available for case No. 615:

1. Born 1-8-1926; C. A. at the time of measurements 6-6.
Binet 9-10-1930, Mental Age 2-2, IQ 46, High-Grade Imbecile.

2. Roentgenographic Record. Radial epiphysis 42, ulnar epiphysis 20, naviculare 25, lunatum 20, triquetrum 19, pisiforme 11, m. majus 25, m. minus 16, capitatum 46, hamatum 32, total area 256, quadrilateral area 244, ratio 1.05, and skeletal months 198. Long naviculare. Greatly accelerated.

3. Anthropometric measurements. Standing height 1354, sitting height 760, arm span 1303, weight 32.3, chest girth 650, chest depth 150, chest width 208, hip width 222, head length 182, head width 151, and head height 124. Excessive development.

4. The medical diagnosis (at age 4-8). High-grade imbecile with multiglandular disturbances, large genitals, and lupus vulgaris on chest and face.

5. Observations by the writer. Appears to be a stunted fifteen-year-old boy, sharp teeth, acne on face and back, bites nails, masturbates, and has pubic and axillary hair.

6. Case history. Father is a coal miner, mother a shoe factory worker, one normal sibling, second born, born at term, with ordinary labor, in wedlock, walked at ten months, has had measles, whooping cough, diphtheria, and scabies.

The records show a much over-developed physique. The excess in development has been calculated in standard deviations from the mean of the six-year-old-group. The following positive deviations were found:

Standing height	4.4	Head length	1.4
Sitting height	6.1	Head width	1.8
Arm span	3.5	Head height	1.7
Chest girth	5.0	Total ossification	18.2
Chest depth	2.5	Quadrilateral area	3.8
Chest width	4.0	Ossification ratio	12.9
Hip width	7.7	Skeletal months	11.1

These results show very significant deviations from the average six-year-old mentally deficient boy. The nearest approach to the six-year mean is in head length which exceeds that average by 1.4 standard deviations. Head size would be expected to more nearly approximate the average than other body dimensions. Height, arm span, chest depth, chest width, and quadrilateral area do not deviate much more than some of the subjects already discussed in this chapter. The sitting height and hip width of case No. 615 are 6.1 and 7.7 standard deviations, respectively, from the mean. The trunk length, therefore, shows a greater proportional development than the increase

¹ Paterson, *op. cit.*, p. 143 ff.

² Englebach and McMahon, *op. cit.*



Figure 53.- A pubertas praecox case at six and a half years of age.

in the extremities. The excessive hip width is a very interesting phenomenon in connection with pubertas praecox. The greatest deviation, however has been found in the carpal development. Skeletal-months evaluations were more than eleven standard deviations above the mean. The ossification ratio was nearly thirteen sigmas above the average, while the total ossified area was more than eighteen standard deviations above the six-year-old average mentally deficient boy. A print of the roentgenogram for this case is shown in Figure 53. Although the hand is relatively small, in relation to his maturity, it can be observed that all of the epiphyses with the exception of the radius and the ulna have already completely fused. The degree of ossification as revealed by Figure 53 has been judged to exceed the sixteen-year-old standard. These data indicate that this case at six and a half years of age is accelerated approximately ten years in skeletal development. The degree of deviation was so great that the writer decided to eliminate this case from the tabulations used in the study. The means reported do not include the measurements of the pubertas praecox case.

The evidence seems to indicate that mentally deficient males have more anomalies of development and deviate to a greater extent from the norm than do children who have a higher mental ability. The so-called "stigmata of degeneration" do not appear to have a diagnostic value when they occur singly. An excessive number of anomalies seems to indicate a lower type of organism and, therefore, a greater likelihood that the subject has a deficient mentality. Bone malformations, anthropometric deviations, and general body disproportions appear more frequently among individuals with a lower level of mental ability. The deviations have been found to be both positive and negative. Anthropometric extremes from the means of their own age groups were positive more frequently than they were negative. These data are not sufficient to say whether this condition is typical or merely a chance variation. It may be a type of evidence which would support the notion that there is a tendency for the extremes to regress toward the mean or the normal in physique. The important point to remember is that anomalies are likely to exist in greater number and with greater severity among mentally deficient persons than in the general population.

SUMMARY AND CONCLUSIONS

It has been the purpose of this study to determine the characteristics of the physical growth of mentally deficient boys. The data consist of eleven anthropometric measurements, an x-ray of the carpal area, a medical diagnosis, the case history, and a careful inspection of 800 subjects in the state institutions at Ft. Wayne, Indiana, and Lincoln, Illinois. Colored boys, the severely crippled, and patients who were suffering from contagious or confining diseases were excluded from the study. Carpal development was analyzed by techniques which have been employed with the University of Chicago Laboratory School boys. Anthropometric averages were compared with means for private-school boys in the Chicago area. An analysis was made of hereditary and environmental factors which may operate to influence the development of the child. Case descriptions and illustrations have been presented in connection with a consideration of certain anomalies of development.

Findings

An analysis of the data has revealed the following characteristics of the growth of mentally deficient boys:

1. The carpal bones develop at a slower rate, grow for a longer time, and reach a lower maximum size than the average Laboratory School boy.
2. The total ossified area in the carpus equals the area of the carpal quadrilateral approximately at age fifteen, which is one full year retarded.
3. The ossification ratio of mentally deficient boys is below the ratio for Laboratory School boys at all ages.
4. The subnormal group becomes increasingly retarded in skeletal-months evaluations until Laboratory School boys have attained maturity. All of the mental defectives have attained carpal maturity at the age of twenty-five, which is approximately four years later than the time at which normal males reach the same degree of carpal development.
5. Mentally deficient boys are on the average below private-school males in all measurements of physical size. The differences are significant for all of the physical variables at maturity.
6. The rate of growth for mental defectives is slower than the average, but growth continues over a greater number of years. The differences in maximum size are not erased by the extended period of growth.
7. Mentally deficient males seem to be more variable in their development than either Laboratory School or private-school boys. The variability for most of the physical traits continues to increase among the subnormal group after normal and superior males have begun to become more homogeneous in size, due to an earlier maturation of the more favored groups.
8. The family stock of mental defectives has a high incidence of parents who are mentally retarded, economically poor, socially low, occupationally inferior, and morally degraded. Home conditions in many families were not conducive to a high type of physical development.
9. The difference in growth among subjects who suffered birth injury and those who came from defective family stock did not seem to be important. The number of cases used for this part of the analysis was too few to permit a definite conclusion.

10. Families into which mentally deficient children are born exceed the average in size. The age of parents at the birth of the child, and birth conditions including birth order do not appear to be highly significant. Approximately one-quarter of the mental defectives were first born children, which is a little high for families with an average of five offspring.

11. Mentally deficient boys were found to be retarded about six months in learning to walk and about eighteen months in the acquisition of speech. The lower-grade defectives were more retarded than the morons.

12. Each subject has had an average of more than five different diseases. There is a definite relationship between the number of illnesses and the mental level.

13. The mortality rate is nearly twice as high among amentas as in the general population. Idiots die at a rate which is nearly five times as rapid as the average. The selection produced by this condition means that individuals who have served as subjects in this study were the most resistant to disease. The chances are that the survival of the fittest was the rule.

14. The incidence of mongolism among the mentally deficient population is so low that the general results were affected only insignificantly. Twenty-two mongolian cases were found in a group of 800 subjects.

15. Secondary sex characteristics indicate that mentally deficient boys reach pubescence very late. The average subject was approximately three years retarded in his sexual development. Accelerated pubescence was observed in a few cases but the rule is just the reverse. The degree of sexual retardation appeared to be related to the degree of the mental defect.

16. Anomalies found in the physical development of mentally deficient boys appeared to be more numerous and more severe than in the general population. However, anomalies can not be considered as distinguishing characteristics among the defective groups, except that one might be suspicious of a mental defect in an individual who had four or five severe physical abnormalities.

17. The foregoing findings are in agreement with a separate comparison of idiots and morons, which revealed that the degree of physical deviation tends to be related to the degree of mental defect. The difference between idiots and morons was greater at sixteen than at eleven years of age. It appears that the growth rates are different for these two groups of mentally deficient subjects.

Conclusions

The results which have been found seem to justify the following conclusions.

1. The growth rate in physical traits is slower among mentally deficient males than for normal boys. The rate of growth appears to be related to the degree of mental defect.

2. The period of growth for subnormal boys is longer than has been found for normal and superior children of the same sex. The maximum physical size appears to be reached on the average at approximately twenty years of age. A slower growth rate and a longer duration of growth indicates an extended period of immaturity.

3. The ultimate size of the average mentally deficient boy is below the mean for private school boys in all physical variables. The prolonged period of physical growth is insufficient to overcome the physical inferiority.

4. The degree of deviation in physical traits appears to be related to the degree of mental defect. Idiots are likely to be inferior to morons, while morons are usually below the average for normal children.

5. There are many unfavorable environmental factors which may contribute to the inferiority in physical development. Bad home conditions, large families, and low social status are not conducive to physical and mental well-being, in spite of the fact that normal children sometimes come out of such environmental surroundings.

6. Developmental features such as, walking, talking, teething, and the onset of pubescence, constitute additional evidence to support the hypothesis that mentally deficient males deviate negatively from the normal with respect to their physical unfolding. The degree of retardation in development appears to be related to the degree of mental defect.

7. The evidence of the entire study seems to point to the general conclusion that mentally deficient boys are likewise physically inferior. Amnesia is a condition which is accompanied by a general organic deficiency. It appears that a feeble mind in a normally developed body is relatively rare. Mental deficiency does not appear to be confined to the central nervous system. A blighted mentality seems to be symptomatic of a calamity which has affected the whole organism.

Implications of the Results

Since the findings indicate a prolonged period of growth, it seems clear that mentally deficient children should be treated as immature individuals for a greater number of years. The cases who are amenable to instruction would doubtless profit from an extended rather than a restricted educational opportunity. If the average boy needs a period of schooling which covers ten years, it is probable that the high-grade moron would profit by a considerably extended educational provision. At any rate, it is absurd to assume that boys who are not yet pubescent should be discharged from the state schools at their sixteenth birthdays because they have satisfied the compulsory school law.

Persons who are responsible for the physical welfare of mentally deficient children should be warned against the use of physical averages for normal children as desirable standards for the deficient class. Mental defectives have growth rates which are peculiar to their own groups. There is no normal height; but there may be norms for deficient, average, and superior children. Each child deserves to be considered in relation to the group of which he is a part. The slower growth rate implies that the period of protection needs to be extended.

The writer is of the opinion that, since many of the families are at such a low mental, economic, and social level, a majority of the mentally deficient children have a more favorable environment for development when they have been placed in the public institutions. In most instances, the earlier the commitment the better are the chances for the child. A prolonged infancy in a mentally deficient child causes the parent to shower extra affection upon these helpless offspring. When the child is finally given over to the care of the state, the bad habits established in the home have to be eradicated. Medical inspection and care are far superior in the state institutions than most of the parents are able to afford.

The social consequences are not a part of the present study, but the writer feels that the state has saved in the end by providing ample custodial, recreational, and educational facilities for the mentally deficient individuals within her borders. The excessive birth rate among families which continue to supply the sub-normal population is a problem of grave social concern.

Needed Research

The present study is in no sense the final word on the growth of mentally deficient individuals. Some of the problems have been raised and tentative answers offered. There is still considerable work that needs to be done with the mentally deficient portion of the population.

1. There is a need for continuous records of the same individuals year after year until they have reached maturity. These defective children, in most instances, have been committed solely to the care of the state. Their behavior may be controlled completely. The present staffs in state institutions have an excellent opportunity to begin the assembling of physical and mental records on a long-time basis.

2. There is a need for a more careful evaluation of the influence of environmental factors upon the growth of mentally deficient children. It would be very valuable to know the influence of institutionalization upon the growth of the child. The institution may be superior to the homes from which the sub-normal children come and still lack some of the requisites for the proper development of the child.

3. A study should be made, with a large number of subjects, to determine whether individuals who are aments because of injury to the central nervous system differ in their growth rate from those persons who are purely the product of a defective germ plasm. The small number of subjects considered in this study were insufficient to justify final conclusions.

4. The evidence in the present study has all tended to support the hypothesis that the degree of the physical deviations is related to the degree of the mental defect. This problem should be attacked by workers with various techniques until the hypothesis is established or entirely disproved.

5. Since the results indicate a longer period of physical growth, it would be extremely valuable to recanvass the evidence with respect to the mental growth of aments. Repeated tests of the same subjects over a period of years should throw light upon this difficult problem.

6. A study of the physical growth of mentally deficient girls is needed to supplement the present findings. Similar data for girls would make it possible to determine sex differences in the physical development of sub-normal children. A comparison of normal and mentally deficient girls would also be a contribution.

It is the hope of the writer that the foregoing results will stimulate other research workers to seek for solutions to the various problems which are connected with the phenomenon of mental deficiency. Research has been in progress for many years with individuals who are at the lower end of the intellectual scale. However, there are many important problems which are as yet unsolved.

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APPENDIX

TABLE XX

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE RADIAL EPIPHYSIS OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	9.4	± .23	11	.90	± .16	18.6
6	13.0	± .49	13	2.70	± .34	22.0
7	15.2	± .63	15	4.46	± .44	26.4
8	16.8	± .45	17	3.63	± .32	29.7
9	18.8	± .44	19	3.59	± .31	33.7
10	22.0	± .62	23	6.45	± .44	39.9
11	27.4	± .67	26	6.73	± .47	45.9
12	28.8	± .62	30	7.10	± .44	52.5
13	33.4	± .60	34	6.64	± .43	59.4
14	39.4	± .98	39	11.45	± .69	69.2
15	45.5	± .86	46	9.59	± .61	80.0
16	51.6	± 1.07	50	11.63	± .75	87.5
17	52.2	± .98	53	11.02	± .70	93.1
18	55.3	± 1.03	54	10.47	± .73	95.3
19	55.1	± 1.24	56	12.05	± .88	98.1
20	57.1	± 1.03	56	10.51	± .73	98.9
21	56.7	± 1.23	56	11.59	± .87	99.1
22	55.5	± 1.23	57	8.57	± .87	99.7
23	57.9	± 1.57	57	11.39	± 1.11	100.0
24	57.4	± .93	58	9.46	± .57	
25	58.5	± 1.62		5.85	± 1.14	

TABLE XXI

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE ULNAR EPIPHYSIS OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
6	.2	± .10	1	.56	± .07	2.1
7	1.0	± .25	1	1.81	± .18	5.6
8	2.5	± .25	2	2.03	± .18	10.3
9	3.6	± .31	4	2.54	± .22	17.2
10	6.0	± .33	6	3.48	± .24	26.6
11	8.9	± .34	8	3.46	± .24	36.1
12	10.3	± .37	11	4.20	± .26	45.9
13	12.8	± .30	13	3.30	± .21	55.8
14	15.9	± .38	16	4.39	± .27	67.0
15	18.1	± .39	18	4.34	± .28	76.4
16	19.5	± .42	19	4.55	± .30	83.3
17	20.6	± .47	21	5.25	± .33	89.3
18	22.4	± .45	22	4.61	± .32	94.4
19	23.1	± .60	23	5.82	± .42	99.6
20	24.0	± .47	23	4.81	± .33	100.0
21	23.1	± .54	23	5.06	± .38	--
22	23.0	± .66	23	4.60	± .47	--
23	23.7	± .72	23	5.22	± .51	--
24	22.4	± .65	23	4.52	± .46	--
25	23.3	± 1.45	--	5.25	± 1.02	--

TABLE XXII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE NAVICULARE OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
6	0.2	± .07	1	0.41	± .05	2.3
7	2.1	± .35	3	2.47	± .25	6.4
8	5.3	± .48	5	3.92	± .34	12.6
9	7.3	± .49	8	4.01	± .35	20.1
10	9.6	± .43	11	4.48	± .30	27.5
11	15.1	± .54	14	5.39	± .38	36.5
12	17.9	± .63	18	7.21	± .44	47.3
13	22.4	± .65	23	7.16	± .46	58.1
14	27.6	± .72	27	8.34	± .51	69.2
15	30.8	± .76	31	8.44	± .54	79.4
16	34.5	± .80	33	8.70	± .56	85.9
17	34.9	± .72	35	8.01	± .51	90.8
18	36.5	± .74	36	7.50	± .52	93.6
19	37.9	± .76	38	7.35	± .54	97.2
20	39.2	± .72	38	7.28	± .51	98.7
21	38.1	± .95	39	8.89	± .67	99.5
22	38.7	± .79	38	5.50	± .56	98.5
23	38.1	± .85	39	6.15	± .60	100.0
24	38.8	± 1.32	39	9.19	± .94	--
25	41.5	± 1.30	--	4.72	± .92	--

TABLE XXIII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE LUNATUM OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	2.7	± .47	3	1.83	± .33	2.1
6	2.2	± .37	3	2.04	± .26	10.7
7	5.1	± .42	4	2.98	± .30	14.3
8	5.8	± .36	6	2.96	± .26	20.8
9	8.2	± .32	8	2.57	± .22	25.3
10	9.4	± .38	11	3.93	± .27	34.1
11	13.9	± .44	13	4.45	± .31	42.2
12	15.6	± .40	16	4.62	± .29	51.0
13	18.5	± .49	19	5.35	± .34	61.0
14	22.0	± .49	22	5.66	± .34	69.8
15	24.0	± .54	25	6.00	± .38	79.6
16	27.6	± .56	26	6.09	± .40	84.7
17	26.8	± .61	28	6.81	± .43	91.2
18	29.9	± .58	29	5.94	± .41	93.5
19	29.6	± .60	30	5.81	± .42	97.4
20	30.5	± .55	30	5.59	± .39	97.7
21	30.3	± .76	31	7.14	± .54	99.4
22	30.9	± .56	30	5.89	± .40	98.7
23	30.2	± .74	31	5.38	± .52	100.0
24	31.2	± .86	31	6.01	± .61	--
25	34.2	± 1.17	--	4.23	± .82	--

TABLE XXIV

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE TRIQUETRUM OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	4.7	+ .45	5	1.75	+ .32	17.5
6	5.0	+ .31	6	1.69	+ .22	20.4
7	7.0	+ .35	7	2.51	+ .25	24.8
8	8.4	+ .30	9	2.44	+ .21	31.0
9	10.2	+ .30	10	2.44	+ .21	36.1
10	11.0	+ .27	12	2.84	+ .19	42.7
11	13.9	+ .28	14	2.83	+ .20	49.3
12	15.7	+ .31	16	3.51	+ .22	57.7
13	18.0	+ .33	18	3.63	+ .23	66.4
14	20.9	+ .36	20	4.16	+ .25	73.7
15	21.6	+ .37	23	4.08	+ .26	82.1
16	25.1	+ .46	24	5.06	+ .33	85.8
17	23.8	+ .39	25	4.39	+ .28	90.9
18	25.7	+ .52	25	5.30	+ .37	92.0
19	26.2	+ .50	26	4.83	+ .35	96.4
20	27.4	+ .46	27	4.64	+ .32	97.8
21	26.7	+ .58	27	5.42	+ .41	99.3
22	27.6	+ .62	27	4.31	+ .44	99.6
23	27.5	+ .59	27	4.31	+ .42	100.0
24	27.1	+ .63	27	4.37	+ .44	--
25	30.3	+ .81	--	2.93	+ .57	--

TABLE XXV

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE PISIFORME OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
9	.2	+ .11	--	.89	+ .08	1.7
10	.4	+ .09	1	.96	+ .06	2.8
11	.9	+ .20	1	1.97	+ .14	6.8
12	2.6	+ .29	3	3.31	+ .20	15.8
13	4.8	+ .37	5	4.04	+ .26	30.5
14	8.7	+ .38	8	4.43	+ .27	47.5
15	11.6	+ .38	12	4.26	+ .27	65.5
16	14.4	+ .42	14	4.61	+ .30	76.3
17	14.5	+ .34	15	3.81	+ .24	84.8
18	16.2	+ .39	16	3.99	+ .28	88.7
19	16.3	+ .53	17	5.17	+ .38	93.8
20	17.3	+ .40	17	4.10	+ .29	95.5
21	17.2	+ .44	17	4.11	+ .31	97.2
22	17.1	+ .54	18	3.76	+ .38	100.0
23	18.6	+ .62	18	4.47	+ .44	--
24	16.9	+ .40	17	2.81	+ .29	--
25	16.5	+ .41	--	1.50	+ .29	--

TABLE XXVI

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE M. MAJUS OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
6	.6	± .21	1	1.17	± .15	3.6
7	2.4	± .33	2	2.32	± .23	7.3
8	4.2	± .37	4	3.03	± .26	13.4
9	6.6	± .40	6	3.27	± .28	18.8
10	7.8	± .40	9	4.19	± .28	27.7
11	12.9	± .41	12	4.07	± .29	35.9
12	14.6	± .46	15	5.30	± .33	45.6
13	17.5	± .45	18	4.90	± .32	55.0
14	22.3	± .49	22	5.74	± .35	66.0
15	25.3	± .58	26	6.45	± .41	77.5
16	28.9	± .67	28	7.26	± .47	83.6
17	28.4	± .53	29	5.89	± .37	86.6
18	30.5	± .61	30	6.24	± .43	92.4
19	32.2	± .73	32	7.07	± .52	97.0
20	32.9	± .58	33	5.85	± .41	100.0
21	33.7	± .77	33	7.20	± .54	--
22	31.8	± .77	33	5.34	± .54	--
23	33.8	± .87	33	6.34	± .62	--
24	31.9	± .83	33	5.77	± .59	--
25	34.2	± 1.03	--	3.73	± .73	--

TABLE XXVII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE M. MINUS OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
6	.8	± .28	1	1.57	± .20	5.2
7	2.0	± .26	2	1.82	± .18	9.9
8	4.1	± .33	4	2.68	± .23	18.1
9	6.5	± .29	6	2.34	± .20	26.3
10	7.8	± .29	8	3.06	± .21	35.3
11	10.4	± .31	10	3.12	± .22	43.5
12	12.0	± .33	12	3.83	± .24	53.0
13	14.4	± .30	14	3.28	± .21	61.6
14	16.5	± .31	16	3.65	± .22	69.8
15	17.8	± .33	18	3.69	± .24	78.0
16	20.2	± .43	19	4.64	± .30	82.8
17	19.6	± .36	20	4.00	± .25	86.6
18	20.6	± .39	21	3.94	± .27	88.8
19	21.7	± .44	22	4.28	± .31	94.8
20	23.6	± .55	23	5.55	± .39	97.8
21	22.7	± .55	23	5.19	± .39	100.0
22	23.2	± .60	23	4.14	± .42	--
23	22.5	± .49	23	3.56	± .35	--
24	21.6	± .62	22	4.33	± .44	--
25	23.0	± .99	--	3.61	± .70	--

TABLE XXVIII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE CAPITATUM OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	14.0	+ .82	15	3.21	+ .58	26.1
6	16.1	+ .56	16	3.09	+ .39	28.9
7	18.7	+ .59	19	4.23	+ .42	34.3
8	23.1	+ .64	22	5.23	+ .46	39.6
9	25.1	+ .55	25	4.46	+ .39	44.6
10	27.1	+ .39	28	4.06	+ .27	50.3
11	32.7	+ .54	32	5.38	+ .38	55.9
12	34.6	+ .60	35	6.85	+ .42	62.9
13	38.9	+ .72	39	7.88	+ .51	69.4
14	43.8	+ .79	43	9.18	+ .56	76.4
15	46.2	+ .85	47	9.44	+ .60	83.6
16	51.2	+ .80	49	8.75	+ .57	87.0
17	49.6	+ .91	51	10.14	+ .64	90.9
18	53.7	+ .89	53	9.06	+ .63	93.8
19	55.2	+ 1.06	55	10.34	+ .75	97.7
20	56.1	+ .90	55	9.19	+ .64	98.4
21	55.0	+ 1.07	56	10.01	+ .75	99.1
22	56.4	+ .74	56	5.14	+ .52	98.9
23	55.8	+ 1.16	56	8.44	+ .82	100.0
24	56.6	+ 1.45	56	10.11	+ 1.03	--
25	62.5	+ 1.75	--	6.35	+ 1.23	--

TABLE XXIX

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE HAMATUM OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	11.3	+ .49	11	1.91	+ .34	26.6
6	11.4	+ .30	12	1.67	+ .21	27.5
7	12.4	+ .35	13	2.46	+ .25	30.6
8	15.2	+ .43	15	3.53	+ .31	35.3
9	17.4	+ .42	17	3.44	+ .30	39.8
10	18.2	+ .31	19	3.28	+ .23	44.9
11	21.9	+ .35	21	3.56	+ .25	50.1
12	24.1	+ .47	25	5.36	+ .33	58.1
13	28.1	+ .46	28	5.10	+ .33	65.6
14	31.6	+ .57	31	6.67	+ .40	72.9
15	33.4	+ .37	34	5.87	+ .37	80.2
16	37.2	+ .58	36	6.34	+ .41	84.2
17	36.8	+ .64	38	7.14	+ .45	88.7
18	39.1	+ .66	39	6.68	+ .47	90.6
19	39.6	+ .74	41	7.21	+ .53	95.3
20	42.8	+ .63	41	6.44	+ .45	96.5
21	40.7	+ .74	42	6.98	+ .53	96.0
22	42.6	+ .70	41	4.88	+ .50	97.2
23	41.6	+ 1.00	43	7.23	+ .70	100.0
24	43.2	+ .82	43	5.70	+ .40	--
25	46.2	+ 1.73	--	6.26	+ 1.22	--

TABLE XXX

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE TOTAL OSSIFIED AREA OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	35.6	+ 3.10	40	12.17	+ 2.19	11.6
6	49.9	+ 2.04	51	11.30	+ 1.44	14.5
7	65.9	+ 2.80	67	19.95	+ 1.98	19.3
8	85.5	+ 2.83	85	23.03	+ 2.00	24.5
9	103.9	+ 2.87	103	23.33	+ 2.03	29.7
10	120.1	+ 2.93	124	30.67	+ 2.07	35.7
11	148.2	+ 3.41	148	34.28	+ 2.41	42.7
12	177.0	+ 3.90	176	44.82	+ 2.76	50.4
13	211.4	+ 3.89	213	42.81	+ 2.75	61.3
14	252.3	+ 4.72	246	55.04	+ 3.34	70.1
15	274.3	+ 4.88	279	54.17	+ 3.45	80.2
16	310.6	+ 5.37	297	58.45	+ 3.79	85.3
17	305.0	+ 5.15	315	57.66	+ 3.64	90.6
18	329.8	+ 5.13	324	52.14	+ 3.63	93.1
19	336.6	+ 6.35	339	61.66	+ 4.89	97.3
20	349.4	+ 5.12	345	52.06	+ 3.62	99.1
21	348.0	+ 6.30	348	59.14	+ 4.46	100.0
22	346.3	+ 5.86	348	40.75	+ 4.14	--
23	349.5	+ 7.03	348	51.07	+ 4.97	--
24	347.5	+ 6.97	348	48.49	+ 4.93	--
25	371.2	+ 5.43	---	19.72	+ 3.84	--

TABLE XXXI

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE QUADRILATERAL AREA OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	151.6	+ 5.57	154	21.85	+ 3.94	49.4
6	158.8	+ 3.96	158	21.95	+ 2.80	50.6
7	164.5	+ 2.93	168	20.85	+ 2.07	53.8
8	179.8	+ 3.68	175	29.86	+ 2.60	56.1
9	182.0	+ 2.33	182	18.91	+ 1.65	58.3
10	185.5	+ 2.35	195	24.58	+ 1.66	62.5
11	217.8	+ 2.57	208	25.88	+ 1.82	66.7
12	219.5	+ 2.80	226	32.17	+ 1.98	72.4
13	240.7	+ 2.87	239	31.54	+ 2.03	76.6
14	256.0	+ 3.59	257	41.85	+ 2.54	82.4
15	273.3	+ 3.73	274	41.36	+ 2.64	87.8
16	293.9	+ 4.10	288	44.66	+ 2.90	92.3
17	295.7	+ 4.36	299	48.78	+ 3.08	95.8
18	307.1	+ 4.04	305	41.07	+ 2.86	97.8
19	313.1	+ 4.66	312	45.32	+ 3.30	100.0
20	315.8	+ 4.26	311	43.30	+ 3.01	--
21	305.3	+ 5.60	309	52.51	+ 3.96	--
22	305.9	+ 4.95	305	34.42	+ 3.50	--
23	302.8	+ 5.59	306	40.59	+ 3.95	--
24	309.5	+ 6.16	307	42.84	+ 4.36	--
25	334.5	+ 5.27	---	19.15	+ 3.73	--

TABLE XXXII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE OSSIFICATION RATIO OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	.287	± .006	.29	2.37	± .43	25.7
6	.308	± .010	.33	5.60	± .71	29.2
7	.396	± .013	.39	8.92	± .89	34.5
8	.474	± .011	.48	7.69	± .77	42.5
9	.565	± .012	.55	10.31	± .82	48.7
10	.611	± .012	.63	12.88	± .87	55.8
11	.728	± .011	.71	10.89	± .77	62.8
12	.799	± .012	.80	13.24	± .82	70.8
13	.861	± .010	.87	11.04	± .71	77.0
14	.964	± .009	.94	10.22	± .62	83.2
15	1.008	± .010	1.01	10.72	± .68	89.4
16	1.052	± .009	1.03	10.23	± .66	91.2
17	1.042	± .010	1.06	10.94	± .69	93.8
18	1.075	± .009	1.06	8.77	± .61	93.8
19	1.074	± .011	1.09	10.79	± .79	96.5
20	1.112	± .008	1.11	8.05	± .59	98.2
21	1.129	± .010	1.12	9.14	± .69	99.1
22	1.133	± .011	1.13	7.79	± .79	100.0
23	1.152	± .010	1.13	6.72	± .66	--
24	1.123	± .010	1.13	7.21	± .73	--
25	1.125	± .019	--	6.93	± 1.35	--

TABLE XXXIII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR THE SKELETAL MONTHS OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	57.4	± 1.80	60	7.07	± 1.27	27.0
6	64.3	± 2.18	66	12.11	± 1.54	29.7
7	77.2	± 1.62	77	11.51	± 1.14	34.7
8	89.4	± 1.64	88	13.36	± 1.16	39.6
9	98.5	± 1.09	98	9.73	± .77	44.1
10	107.2	± 1.31	110	13.72	± .93	49.6
11	122.9	± 1.37	121	13.75	± .97	54.5
12	133.4	± 1.60	133	18.32	± 1.12	59.9
13	142.3	± 1.22	145	13.47	± .86	65.3
14	158.8	± 1.21	156	14.08	± .85	70.3
15	168.1	± 1.55	170	17.25	± 1.10	76.6
16	183.3	± 1.77	180	19.24	± 1.25	81.1
17	189.8	± 1.68	191	18.81	± 1.19	86.0
18	198.5	± 1.87	198	18.97	± 1.32	89.2
19	206.9	± 1.94	207	18.88	± 1.37	93.3
20	214.6	± 1.28	212	13.00	± .90	95.5
21	214.7	± 1.85	216	17.36	± 1.31	97.3
22	218.5	± 1.53	218	10.65	± 1.08	98.2
23	220.3	± 1.11	220	8.23	± .79	99.1
24	221.4	± .39	221	2.62	± .28	99.6
25	220.0	---	222	---	---	100.0

TABLE XXXIV

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR STANDING HEIGHT OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	1037.0	+13.62	1055	53.45	+ 9.63	64.1
6	1090.6	+10.89	1087	60.40	+ 7.70	66.0
7	1133.8	+10.43	1137	74.20	+ 7.38	69.0
8	1186.2	+ 9.88	1181	80.23	+ 6.98	71.7
9	1223.8	+ 6.16	1224	54.80	+ 4.36	74.3
10	1262.0	+ 7.41	1275	77.63	+ 5.24	77.4
11	1340.8	+ 6.60	1327	66.35	+ 4.66	80.5
12	1378.8	+ 6.54	1378	75.05	+ 4.62	83.6
13	1414.7	+ 7.49	1420	82.40	+ 5.30	86.2
14	1467.3	+ 8.19	1466	95.55	+ 5.79	89.0
15	1515.1	+10.09	1527	112.03	+ 7.13	92.7
16	1598.6	+ 8.63	1571	94.00	+ 6.10	95.4
17	1598.0	+10.78	1606	120.38	+ 7.62	97.5
18	1622.7	+ 9.90	1625	100.63	+ 7.00	98.6
19	1654.5	+12.51	1639	121.58	+ 8.85	99.5
20	1639.7	+ 8.98	1647	91.28	+ 6.35	100.0
21	1646.4	+ 8.91	1642	83.60	+ 6.30	--
22	1641.6	+ 9.67	1639	67.28	+ 6.84	--
23	1628.0	+14.75	1640	109.30	+10.43	--
24 & 25	1650.5	+14.01	1642	95.88	+ 9.90	--

TABLE XXXV

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR SITTING HEIGHT OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	586.3	+ 7.00	592	27.45	+ 4.95	67.7
6	602.4	+ 4.64	604	25.74	+ 3.28	69.1
7	622.4	+ 3.91	623	27.78	+ 2.76	71.3
8	644.0	+ 4.71	642	38.28	+ 3.33	73.4
9	659.5	+ 3.14	659	27.95	+ 2.22	75.4
10	674.1	+ 3.53	680	36.99	+ 2.50	77.8
11	706.6	+ 3.22	701	32.34	+ 2.27	80.2
12	721.8	+ 2.97	721	34.10	+ 2.10	82.5
13	735.8	+ 3.40	740	37.43	+ 2.41	84.7
14	763.5	+ 4.21	762	49.07	+ 2.97	87.2
15	788.0	+ 5.40	793	59.97	+ 3.82	90.7
16	828.7	+ 5.10	816	55.50	+ 3.60	93.4
17	830.2	+ 5.72	838	64.08	+ 4.05	95.9
18	854.2	+ 5.10	852	51.87	+ 3.61	97.5
19	872.6	+ 6.10	867	59.30	+ 4.31	99.2
20	873.7	+ 3.96	874	40.20	+ 2.80	100.0
21	874.5	+ 5.42	871	50.87	+ 3.83	--
22	865.0	+ 6.18	869	42.98	+ 4.37	--
23	867.0	+ 6.77	867	50.19	+ 4.79	--
24 & 25	870.5	+ 4.78	869	36.11	+ 3.38	--

TABLE XXXVI

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR ARM SPAN OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	1029.9	+23.53	1045	92.30	+16.64	62.3
6	1074.5	+11.90	1074	65.98	+ 8.41	64.5
7	1117.4	+ 8.42	1125	59.87	+ 5.95	67.6
8	1172.8	+11.37	1162	92.35	+ 8.04	69.8
9	1196.7	+ 7.39	1206	65.70	+ 5.22	72.5
10	1248.5	+ 7.50	1261	78.60	+ 5.30	75.8
11	1336.5	+ 7.95	1317	80.00	+ 5.62	79.2
12	1365.8	+ 7.04	1372	80.85	+ 4.98	82.5
13	1412.5	+ 8.55	1415	94.08	+ 6.05	85.0
14	1465.6	+ 9.18	1463	107.10	+ 6.49	87.9
15	1510.7	+10.67	1524	118.43	+ 7.54	91.6
16	1606.5	+ 9.50	1577	103.50	+ 6.72	94.8
17	1612.9	+11.30	1618	126.53	+ 7.99	97.2
18	1633.3	+11.79	1637	119.85	+ 8.34	98.4
19	1664.3	+13.30	1656	129.28	+ 9.41	99.5
20	1669.5	+11.62	1663	118.05	+ 8.21	100.0
21	1655.8	+13.00	1662	121.93	+ 9.19	--
22	1660.9	+12.48	1649	86.75	+ 8.82	--
23	1632.0	+17.25	1647	127.88	+12.20	--
24 & 25	1649.5	+14.91	1644	112.73	+10.55	--

TABLE XXXVII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR WEIGHT OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	16.6	± .41	17	1.59	+ .29	30.9
6	17.9	± .28	18	1.55	+ .20	32.7
7	20.0	± .40	20	2.89	+ .29	36.4
8	21.9	± .44	22	3.57	+ .31	40.0
9	23.8	± .37	24	3.33	+ .27	43.6
10	25.8	± .40	26	4.24	+ .29	47.3
11	29.4	± .46	29	4.58	+ .32	52.7
12	31.6	± .45	31	5.20	+ .32	56.4
13	34.0	± .47	35	5.19	+ .33	63.6
14	39.3	± .71	38	8.27	+ .50	69.1
15	41.9	± .79	43	8.72	+ .56	78.2
16	47.1	± .77	46	8.34	+ .54	83.6
17	50.2	± 1.12	50	12.52	+ .79	92.7
18	53.3	± 1.15	53	11.65	+ .81	96.4
19	56.0	± 1.36	55	13.26	+ .96	100.0
20	57.2	± 1.37	55	13.87	+ .97	--
21	56.5	± .97	55	9.08	+ .68	--
22	51.6	± 1.03	55	7.13	+ .73	--
23	54.7	± 1.53	55	11.30	+ 1.08	--
24 & 25	58.0	± 1.15	57	8.71	+ .82	--

TABLE XXXVIII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR CHEST GIRTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	530.6	+ 6.42	534	25.17	+ 4.53	65.3
6	541.3	+ 3.88	547	21.54	+ 2.75	66.8
7	570.3	+ 3.04	563	21.65	+ 2.15	68.8
8	576.5	+ 3.39	578	27.53	+ 2.40	70.6
9	588.3	+ 2.94	592	26.55	+ 2.11	72.3
10	611.1	+ 3.56	610	37.28	+ 2.52	74.5
11	629.3	+ 3.80	631	38.18	+ 2.68	77.1
12	651.5	+ 3.64	672	41.81	+ 2.58	79.1
13	660.5	+ 3.80	667	41.75	+ 2.68	82.2
14	704.7	+ 5.43	695	63.33	+ 3.84	84.9
15	719.7	+ 4.59	726	50.96	+ 3.25	88.7
16	754.0	+ 4.99	746	54.38	+ 3.53	91.2
17	765.7	+ 6.56	772	73.50	+ 4.64	94.3
18	799.0	+ 7.96	793	90.91	+ 5.63	96.9
19	815.7	+ 7.33	813	71.27	+ 5.19	99.3
20	825.2	+ 7.03	817	71.43	+ 4.97	99.8
21	811.1	+ 6.13	810	57.51	+ 4.34	99.0
22	792.7	+ 7.43	811	51.66	+ 5.25	99.1
23	830.4	+ 8.02	818	59.42	+ 5.67	100.0
24 & 25	830.7	+ 7.55	831	57.08	+ 5.34	--

TABLE XXXIX

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR CHEST DEPTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	127.1	+ 2.37	125	9.31	+ 1.68	64.8
6	122.2	+ 1.98	127	10.96	+ 1.40	65.8
7	130.4	+ 1.64	128	11.63	+ 1.16	66.3
8	131.5	+ 1.15	133	9.33	+ .81	68.9
9	136.3	+ 1.36	136	12.07	+ .96	70.5
10	139.5	+ 1.12	140	11.75	+ .79	72.5
11	142.9	+ 1.31	144	13.22	+ .93	74.6
12	148.8	+ 1.15	147	13.16	+ .81	76.2
13	148.8	+ 1.21	152	13.36	+ .86	78.8
14	159.4	+ 1.29	158	15.01	+ .91	81.9
15	166.9	+ 1.28	165	14.21	+ .91	85.5
16	170.1	+ 1.48	171	16.08	+ 1.04	88.6
17	176.8	+ 1.84	176	20.65	+ 1.30	91.2
18	181.8	+ 1.73	183	17.57	+ 1.22	94.3
19	189.7	+ 1.80	187	17.52	+ 1.27	96.9
20	189.7	+ 2.17	190	22.06	+ 1.53	98.4
21	189.9	+ 1.63	189	15.26	+ 1.15	97.9
22	186.3	+ 1.10	191	7.58	+ .77	99.9
23	196.9	+ 2.06	193	15.27	+ 1.46	100.0
24 & 25	195.2	+ 1.78	196	13.45	+ 1.26	--

TABLE XL

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR CHEST WIDTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	178.9	± 3.16	176	12.39	± 2.23	69.6
6	171.1	± 1.68	176	9.31	± 1.19	69.6
7	179.4	± 1.37	178	9.77	$\pm .97$	70.4
8	183.4	± 1.32	183	10.73	$\pm .94$	72.3
9	185.7	± 1.52	188	13.48	± 1.07	74.3
10	195.0	± 1.23	193	12.92	$\pm .87$	76.3
11	199.6	± 1.20	200	12.05	$\pm .85$	79.1
12	204.5	± 1.06	205	12.14	$\pm .75$	81.0
13	209.9	± 1.12	212	12.36	$\pm .79$	83.8
14	221.3	± 1.36	218	15.83	$\pm .96$	86.2
15	223.3	± 1.53	227	16.94	± 1.08	89.7
16	235.8	± 1.67	231	18.21	± 1.18	91.3
17	234.1	± 1.66	239	18.61	± 1.18	94.5
18	247.6	± 2.08	244	21.16	± 1.47	96.5
19	250.6	± 2.11	251	20.50	± 1.49	99.2
20	253.7	± 1.90	252	19.32	± 1.34	99.6
21	251.1	± 1.87	252	17.34	± 1.32	99.6
22	249.9	± 3.10	251	21.55	± 2.19	99.2
23	252.1	± 3.03	253	22.45	± 2.14	100.0
24 & 25	257.0	± 1.91	255	14.43	± 1.35	--

TABLE XLI

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR HIP WIDTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	169.4	± 2.69	171	10.57	± 1.91	63.8
6	174.4	± 1.12	175	6.23	$\pm .79$	65.3
7	182.3	± 1.44	181	10.27	± 1.02	67.5
8	186.7	± 1.45	188	11.81	± 1.03	70.1
9	194.3	± 1.38	197	12.30	$\pm .98$	73.5
10	200.6	± 1.22	202	12.82	$\pm .87$	75.4
11	210.8	± 1.29	209	12.93	$\pm .91$	78.0
12	215.5	± 1.27	217	14.58	$\pm .90$	81.0
13	223.6	± 1.25	223	13.78	$\pm .89$	83.2
14	231.0	± 1.69	231	19.75	± 1.20	86.2
15	237.5	± 1.57	240	17.41	± 1.11	89.5
16	252.6	± 1.58	248	17.24	± 1.12	92.5
17	255.1	± 2.20	256	24.66	± 1.56	95.5
18	259.2	± 2.01	260	20.45	± 1.42	97.0
19	265.4	± 2.78	264	27.06	± 1.97	98.5
20	268.4	± 2.37	268	24.07	± 1.67	100.0
21	270.6	± 1.50	264	14.09	± 1.06	--
22	252.3	± 3.53	262	24.58	± 2.50	--
23	263.6	± 2.97	262	22.00	± 2.10	--
24 & 25	271.4	± 2.14	269	16.13	± 1.51	--

TABLE XLII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR HEAD LENGTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	170.3	± 1.41	170	5.52	± 1.00	90.4
6	170.3	± 1.54	172	8.54	± 1.09	91.5
7	175.7	± 1.10	172	7.81	± .78	91.5
8	169.7	± 1.44	172	11.69	± 1.02	91.5
9	170.8	± .86	172	7.62	± .61	91.5
10	175.2	± .91	175	9.57	± .65	93.1
11	178.2	± .75	177	7.52	± .53	94.1
12	178.5	± .73	178	8.43	± .52	94.7
13	178.2	± .99	179	10.84	± .70	95.2
14	180.2	± .81	180	9.47	± .57	95.7
15	180.4	± .92	182	10.25	± .65	96.8
16	184.6	± .61	183	6.60	± .43	97.3
17	183.1	± .71	184	8.14	± .51	97.9
18	185.3	± .95	185	9.62	± .67	98.4
19	186.9	± .71	186	6.89	± .50	98.9
20	187.0	± 1.05	188	10.67	± .74	100.0
21	183.7	± .86	188	8.02	± .61	--
22	188.2	± 1.48	188	10.26	± 1.04	--
23	185.6	± .97	187	7.21	± .69	--
24 & 25	188.5	± 1.28	188	9.68	± .91	--

TABLE XLIII

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR HEAD WIDTH OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	135.3	± 1.52	135	5.97	± 1.08	91.2
6	135.7	± 1.50	136	8.31	± 1.06	91.9
7	137.0	± 1.11	137	7.86	± .78	92.6
8	138.1	± .98	137	7.95	± .69	92.6
9	135.8	± .77	137	6.83	± .54	92.6
10	137.8	± .64	138	6.73	± .45	93.2
11	141.7	± .56	140	5.62	± .40	94.6
12	141.4	± .55	142	6.25	± .39	95.9
13	142.6	± .61	142	6.70	± .43	95.9
14	143.0	± .57	143	6.60	± .40	96.6
15	142.8	± .64	144	7.07	± .45	97.3
16	146.2	± .59	145	6.39	± .41	98.0
17	145.2	± .71	146	7.90	± .50	98.7
18	147.6	± .57	147	5.77	± .40	99.3
19	147.7	± .79	147	7.72	± .56	99.3
20	145.5	± .76	146	7.76	± .54	98.7
21	145.4	± .97	145	9.13	± .69	98.0
22	145.6	± 1.43	147	9.96	± 1.01	99.3
23	149.2	± 1.05	148	7.77	± .74	100.0
24 & 25	149.0	± .94	149	7.11	± .67	--

TABLE XLIV

MEANS, STANDARD DEVIATIONS, AND THE PER CENT OF THE AVERAGE
MAXIMUM FOR HEAD HEIGHT OF MENTALLY DEFICIENT BOYS

Age	Mean	P. E.	Smoothed Mean	Standard Deviation	P. E.	Per Cent of Mean Maximum
5	117.7	+ 1.15	116.8	4.49	+ .81	96.4
6	114.9	+ .97	117.0	5.39	+ .69	96.5
7	118.2	+ .82	116.9	5.81	+ .58	96.4
8	117.4	+ .96	117.2	7.81	+ .68	96.7
9	116.1	+ .62	116.9	5.50	+ .44	96.4
10	117.3	+ .45	117.3	4.75	+ .32	96.8
11	118.5	+ .52	118.0	5.24	+ .37	97.4
12	118.2	+ .49	118.5	5.58	+ .34	97.8
13	118.9	+ .56	118.3	6.14	+ .40	97.6
14	117.9	+ .51	118.9	5.98	+ .36	98.1
15	120.0	+ .57	119.0	6.37	+ .41	98.2
16	121.1	+ .44	120.6	4.82	+ .31	99.5
17	120.7	+ .54	121.0	6.05	+ .38	99.8
18	121.4	+ .45	121.2	4.59	+ .32	100.0
19	121.6	+ .46	121.1	4.51	+ .33	--
20	120.3	+ .57	120.9	5.80	+ .40	--
21	121.1	+ .72	120.9	6.78	+ .51	--
22	121.3	+ 1.28	120.7	8.88	+ .90	--
23	119.7	+ .78	120.6	5.77	+ .55	--
24 & 25	120.9	+ .76	120.5	5.71	+ .53	--

TABLE XLV

THE APPEARANCE OF SECONDARY SEX CHARACTERISTICS
IN MENTALLY DEFICIENT BOYS

Class	Per Cent at each Age										
	12	13	14	15	16	17	18	19	20	21	Above 21
Class A											
Pre-Pubescent*	100	100	77	83	62	39	29	22	15	31	13
Pubescent	0	0	15	0	31	56	50	56	15	15	0
Post-Pubescent	0	0	8	17	8	6	21	22	70	54	88
Class B											
Pre-Pubescent	100	100	85	56	45	18	22	6	0	8	C
Pubescent	0	0	15	39	40	36	33	6	13	8	0
Post-Pubescent	0	0	0	6	15	45	44	88	87	83	100
Class C											
Pre-Pubescent	96	95	86	65	52	18	7	18	0	0	0
Pubescent	4	5	10	20	19	53	27	18	25	13	0
Post-Pubescent	0	0	3	15	29	29	67	65	75	87	100
All Subjects											
Pre-Pubescent	99	98	84	68	52	25	19	14	6	13	4
Pubescent	2	2	13	20	30	47	36	21	17	13	0
Post-Pubescent	0	0	3	13	19	28	45	65	77	75	96

*Subjects were considered pre-pubescent until there was evidence of either axillary hair or a slight beard. Post-pubescence as used in this study means the presence of pubic and axillary hair with a slight indication of a beard.

TABLE XLVI

THE DISTRIBUTION OF THE SUBJECTS USED IN THE STUDY ACCORDING
TO THE NUMBER OF YEARS SPENT IN THE INSTITUTION

Years	Class A		Class B		Class C		All Subjects	
	N	Per Cent	N	Per Cent	N	Per Cent	N	Per Cent
0	20	10.5	38	13.5	55	18.0	113	14.5
1	16	8.4	28	10.0	44	14.4	88	11.3
2	8	4.2	27	9.6	35	11.4	70	9.0
3	11	5.8	30	10.7	22	7.2	63	8.1
4	7	3.7	17	6.0	30	9.8	54	6.9
5	10	5.3	27	9.6	28	9.2	65	8.4
6	8	4.2	22	7.8	17	5.6	47	6.0
7	26	13.7	18	6.4	26	8.5	70	9.0
8	13	6.8	15	5.3	20	6.5	48	6.2
9	21	11.1	10	3.6	8	2.6	39	5.0
10	13	6.8	15	5.3	2	0.7	30	3.9
11	9	4.7	15	5.3	3	1.0	27	3.5
12	5	2.6	4	1.4	2	0.7	11	1.4
13	3	1.6	6	2.1	3	1.0	12	1.5
14	2	1.1	1	0.4	2	0.7	5	0.6
15	8	4.2	6	2.1	4	1.3	18	2.3
16	3	1.6	1	0.4	2	0.7	6	0.8
17	6	3.2	0	0.0	3	1.0	9	1.2
18	1	0.5	1	0.4	0	0.0	2	0.4
Mean	6.90 $\pm$.21		5.06 $\pm$.16		4.06 $\pm$.15		5.10 $\pm$.10	
Standard Deviation	4.30 $\pm$.15		4.06 $\pm$.12		3.77 $\pm$.10		4.26 $\pm$.07	

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